

## Problems of the modernisation of 20th-century healthcare facilities based on the example of hospitals within the Lubelskie Voivodeship

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**Abstract:** Most hospitals in Poland date back to the 20th century. Due to developments in technology and medicine, these buildings need to be adapted to meet modern needs. Due to these needs and the possibility of EU funding for hospitals, modernisation has become an extremely topical subject. The aim of the research was to identify what types of modernisation work had been carried out after 2004 and to identify the main problems associated with this work. The subjects of the study were 38 hospitals from the Lubelskie Voivodeship in which various types of modernisation work had been carried out. Based on the data collected on these hospitals, interviews with selected managers and the authors' own experience of working on the modernisation of hospitals from the 20th century, seven main problems associated with the ten different modernisation works identified were distinguished. The authors formulated ten questions which can be helpful to hospital managers before embarking on building upgrades and that will help them define the main problems, objectives and a more holistic rather than fragmented approach to adapting hospitals to modern requirements.

**Keywords:** architecture of healthcare facilities, hospital modernisation, hospitals of the 20th century

### 1. Introduction

Most public health facilities are buildings constructed in the second half of the 20th century. The immediate need to undertake modernisation work is often not so much a specific need, but the possibility of obtaining financial support under some grant programme. In Poland, several programmes aimed at supporting energy and environmental efficiency improvements are offered by the state and the EU. Hospitals (health institutions), public administration and educational buildings have so far been allocated the highest number of subsidies for energy efficiency improvements among all building types between 2014 and 2020 – 54% of the available funds. At the same time, as of January 2021, the “Regulation of

the Minister of Infrastructure on 12 April 2002 on technical conditions which should correspond to the buildings and their location” has changed, which has meant that buildings thermo-modernised in previous years no longer meet the current requirements and may be eligible for upgraded building work.

In some cases, modernisation can lead to a comprehensive revitalisation of the entire hospital campus, covering a broader scope than just thermal modernisation of individual facilities and internal renovations in the facilities. The entire external infrastructure of the hospital, roads, communication, spaces of different nature (public, green, car parks, etc.) are then upgraded and/or modified.

Currently, 7 billion Polish zloty is planned to be spent on modernising hospitals [1]. In order for this amount to be used appropriately, it is necessary to analyse the work carried out to date and its effects. The research objective is to identify and systematise issues related to the problems of adapting hospital buildings from the second half of the 20th century to contemporary needs. The practical objective is to systematise the problems affecting the poor quality, errors, conflicts and uneconomic solutions of hospital modernisation.

## **2. State of research**

A valuable piece of literature on the typology and characteristics of 20th-century hospitals in Poland is the book by J. Juraszyński [2]. The modernisation of hospitals in Poland is a current topic in the context of changes in regulations and the need to adapt buildings to modern requirements. The modernisation and protection of historic hospitals had been written about in recent years by Piotr Gerber [3-6]. The subject of modernisation of hospitals, not only of historic hospitals, was also raised in several publications by J. Bąkowski and J. Poplatek [7-9]. A. Sopol and A. Ploch described aspects of modernisation of operating theatres [10-11]. Other aspects of the modernisation, renovation and also construction of hospitals were addressed, among others, by G. Wilson et al [12-13].

The topic of teaching hospitals in the context of functional-spatial layouts as an element of the development strategy of Polish teaching hospitals was raised by M. Łukasik in her doctoral thesis [14]. At the Faculty of Architecture of the Silesian University of Technology, a publication on hospitals was published in recent years as the culmination of many years of research on this topic, dealing with the role of research in improving the quality of hospital functioning [15]. A book by M. P. Murphy and J. Mansfield, in which they describe the typology of hospitals in the context of a direct reflection of innovation in healthcare over the centuries and the relationship between hospital forms and the ever-changing demands of medicine, may be of relevance in the context of hospital modernisation [16].

## **3. Study area**

The study area covered the Lubelskie Voivodeship. There are currently 110 health centres in Lubelskie Voivodeship, including nationwide hospitals, voivodeship hospitals, district hospitals, city hospitals, rural hospitals, ambulance stations and sanitary-epidemiological stations. Of these centres, 38 facilities were selected for detailed study (Fig. 1), including nationwide, voivodeship (3rd level) and district hospitals (1st and 2nd level) [17].

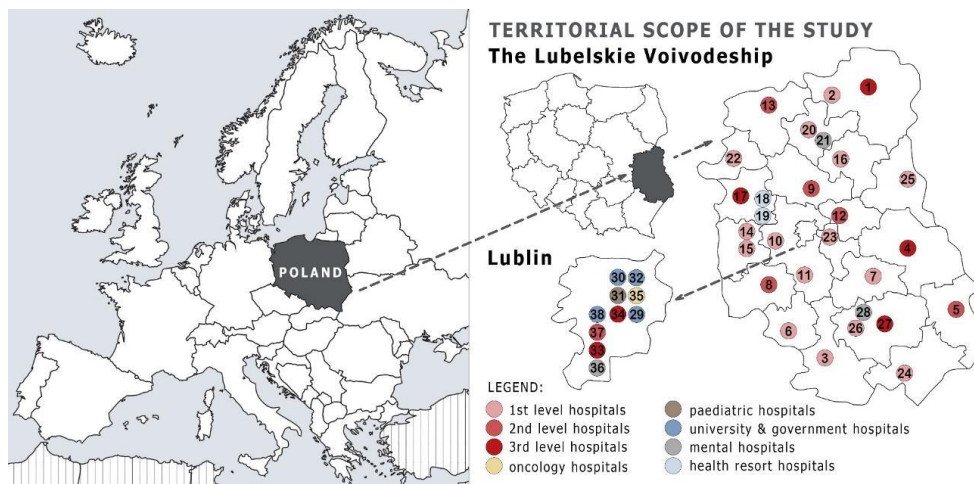


Fig. 1. Territorial scope of the study covering 38 hospitals in Lubelskie Voivodeship, compiled by the authors, 2022.

#### 4. Research methods

The research was based on the collection and analysis of available information on the condition of the material resource of healthcare facilities - hospital buildings, analysis of problems occurring in facilities recognised as a reference and the situation on the construction market in terms of public procurement for the modernisation of hospitals in 2007-2013 and 2014-2021.

In the first stage of the research, the existing stock of healthcare facilities in the Lubelskie Voivodeship was analysed. The time of construction of individual hospitals and their parts were determined, as well as the scope of modernisation works carried out after 2004. Thirty-eight facilities were selected for detailed analysis. Data was obtained from hospital managers, reporting and information websites and general contractors. The study also took into account the authors' own experience of working on modernisation projects for selected hospitals in the Lubelskie Voivodeship. The condition of the facilities was verified in situ. In parallel, a literature study was carried out based on indexed scientific journals and available literature on the subject.

Tab. 1. Summary of hospitals surveyed, indicating the facility's reference level, developed by the authors, 2022

| No. | Location of hospitals surveyed                                 | Hospital reference level | No. | Location of hospitals surveyed                                     | Hospital reference level |
|-----|--|--------------------------|-----|--|--------------------------|
| 1.  | Voivodeship Specialist Hospital in Biała Podlaska              | 3 <sup>rd</sup> level    | 20. | Independent Public Health Care Facility in Radzyń Podlaski         | 1 <sup>st</sup> level    |
| 2.  | Independent Public Health Care Facility in Międzyrzec Podlaski | 1 <sup>st</sup> level    | 21. | Voivodeship Hospital for the Nervous and Mentally Ill in Suchowola | Mental Health Hospital   |

|     |   |        |                        |     |   |                    |                        |
|-----|---|--------|------------------------|-----|---|--------------------|------------------------|
| 3.  | Independent Health Care Facility in Biłgoraj        | Public | 1 <sup>st</sup> level  | 22. | Independent Health Care Facility in Ryki                            | Public             | 1 <sup>st</sup> level  |
| 4.  | Independent Health Care Facility in Chełm           | Public | 3 <sup>rd</sup> level  | 23. | Independent Health Care Facility in Świdnik                         | Public             | 1 <sup>st</sup> level  |
| 5.  | Independent Health Care Facility in Hrubieszów      | Public | 2 <sup>nd</sup> level  | 24. | Independent Health Care Facility in Tomaszów Lubelski               | Public             | 1 <sup>st</sup> level  |
| 6.  | Independent Health Care Facility in Janów Lubelski  | Public | 1 <sup>st</sup> level  | 25. | Independent Health Care Facility in Włodawa                         | Public             | 1 <sup>st</sup> level  |
| 7.  | Independent Health Care Facility in Krasnystaw      | Public | 1 <sup>st</sup> level  | 26. | Independent Health Care Facility in Szczepleszyn                    | Public             | 1 <sup>st</sup> level  |
| 8.  | Independent Health Care Facility in Kraśnik         | Public | 2 <sup>nd</sup> level  | 27. | Pope John Paul II Public Voivodeship Hospital Zamość                | Independent        | 3 <sup>rd</sup> level  |
| 9.  | Independent Health Care Facility in Lubartów        | Public | 2 <sup>nd</sup> level  | 28. | Independent Voivodeship Hospital in Radecznica                      | Public Psychiatric | Mental Health Hospital |
| 10. | Independent Health Care Facility in Bełżyce         | Public | 1 <sup>st</sup> level  | 29. | Independent Hospital No. 1 in Lublin                                | Public Clinical    | University Hospital    |
| 11. | Independent Health Care Facility in Bychawa         | Public | 1 <sup>st</sup> level  | 30. | Independent Hospital No. 4 in Lublin                                | Public Clinical    | University Hospital    |
| 12. | Independent Health Care Facility in Łęczna          | Public | 2 <sup>nd</sup> level  | 31. | Professor Antoni Gębala Children's Clinical Hospital in Lublin      | Public             | Paediatric Hospital    |
| 13. | Independent Health Care Facility in Łuków           | Public | 2 <sup>nd</sup> level  | 32. | Witold Chodźko Institute of Rural Medicine in Lublin                | Public             | University Hospital    |
| 14. | Independent Health Care Facility in Opole Lubelskie | Public | 1 <sup>st</sup> level  | 33. | Stefan Cardinal Wyszyński Voivodeship Specialist Hospital in Lublin | Public             | 3 <sup>rd</sup> level  |
| 15. | Independent Health Care Facility in Poniatowa       | Public | 1 <sup>st</sup> level  | 34. | Jan Boży Voivodeship Hospital in Lublin                             | Independent Public | 3 <sup>rd</sup> level  |
| 16. | Independent Health Care Facility in Parczew         | Public | 1 <sup>st</sup> level  | 35. | Lublin Oncology Centre  |                    | Oncology Hospital      |
| 17. | Independent Health Care Facility in Puławy          | Public | 3 <sup>rd</sup> level  | 36. | Prof. M. Kaczyński Neuropsychiatric Hospital in Lublin              | Public             | Mental hospital        |
| 18. | Railway Spa Hospital in Nałęczów                    |        | Health Resort Hospital | 37. | District Railway Hospital in Lublin                                 | Public             | 2 <sup>nd</sup> level  |
| 19. | Independent Health Care Facility in Nałęczów        | Public | Health Resort Hospital | 38. | MSWiA Hospital in Lublin  |                    | Government Hospital    |

## 5. Time frame of the establishment of the individual hospitals surveyed

As a result of the study, the age of the functioning buildings of public health care hospitals in the Lublin Voivodeship was determined. Before 1945, 26.3% of hospitals in this area were built. Most of the hospitals surveyed were built between 1946 and 1989 (86.8%), which is related to the large hospital construction programme in post-war Poland. The fewest new hospitals were built after 1989 (Fig. 2). Most of the facilities from these years have recently undergone modernisation or are in the process of it.

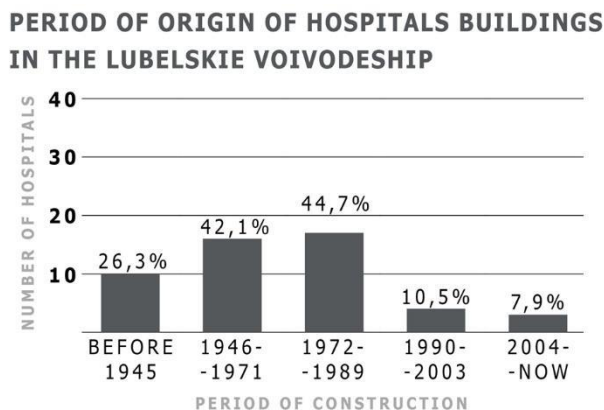


Fig. 2. Results of the survey on the age of hospitals in Lubelskie Voivodeship, compiled by the authors, 2022.

## 6. Results. Scope and problems of modernisation work within 20th-century hospitals

### 6.1. Reasons for modernising 20th-century hospitals

Built in the second half of the 20th century, hospital buildings mostly underwent only current renovations until early 21st century. It was not until a series of legal changes, most of which are linked to the need to implement EU policy, combined with growing public expectations for an increase in the quality of healthcare services, that modernisation work intensified.

Changes to the “Regulation of the Minister of Infrastructure on 12 April 2002 on technical conditions, which should correspond to the buildings and their location” in 2012 resulted in the need to thermo-modernise hospitals that did not meet the requirements for heat transfer coefficients, among other things. In 2020, further changes were made to the regulation, defining these coefficients more strictly. Therefore, some of the hospitals that did not carry out thermal modernisation before 2020 did so after 2020 or are currently in the process of doing so. Healthcare facilities are a group of facilities generating the highest energy consumption in Poland (EP, PK) [18]. The high energy demand in these buildings is mainly due to the specifics of their function, but also to their design and the current energy efficiency requirements.

Climate change and energy-saving issues are important factors determining the direction of modernisation work in hospital facilities, but functional and utility aspects are no less important.

The first guidelines for the organisation of Hospital Emergency Departments appeared with the Ordinance of the Minister of Health in 2014 (modernisation of the ED in the 6 hospitals surveyed). The new regulation for EDs required a helipad for emergency helicopters [19]. In order to bring the hospital wards into compliance with the requirements of the Minister of Health, the majority of hospitals have been modernised.

Public hospitals are in competition with each other due to the healthcare financing system. The appearance of the facility and patient comfort, linked to the architectural quality of the building, are becoming important elements in assessing the quality and perception of the services provided, which is another reason for undertaking modernisation work.

## 6.2. Identified modernisation works

Modernisation works in the surveyed facilities were mostly carried out in the second decade of the 21st century. Thermo-modernisations were most often carried out, which included insulation (or thermal insulation) of the elevation and roof, and replacement of window and door joinery. Sometimes, the scope was extended to include upgrading the heating system and installing photovoltaic panels on the roof. In half of the surveyed facilities, wards were also renovated to improve their functionality, adapt them to modern requirements and provide them with new equipment. Operating theatres also needed adaptation to modern requirements, but these were only modernised in 34.2% of hospitals (Fig. 3).

Due to changes in Polish regulations, some Hospital Emergency Departments required modernisation, reconstruction or expansion to meet the requirements of the Minister of Health. In Lubelskie Voivodeship, this included 21.1% of hospitals. Some facilities required the construction or modernisation of heliports.

In the last two decades, 31.6% of hospitals were extended with new wards and in the case of 10.5% of facilities this involved the construction of a completely new pavilion. Facilities which did not meet modern requirements and were unsuitable for their current function underwent reconstruction, extension and change of use of the pavilion. In some cases, this change was a non-medical function.

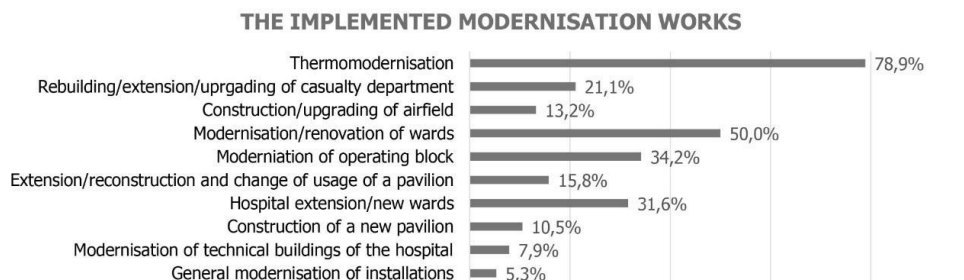


Fig. 3. Identified modernisation work in the surveyed hospitals, compiled by the authors, 2022.

Installation and technical aspects are the least numerous group covered by modernisation. Only 7.9% of the hospitals surveyed had technical buildings upgraded. The general modernisation of the hospital's installations was carried out in 5.3% of the facilities, which is a clear omission of a very important part of the hospital's infrastructure, a key

element for proper functioning. Most often, installations are renovated partially, for example, during the renovation of a ward. At the same time, this does not include all installations, but mainly leads to replacing heating, mechanical ventilation or installing air conditioning in selected rooms. In most cases, the electrical or plumbing installations remain unchanged, with only the necessary extensions. In the modernisation of bed wards, they are usually renovated by adding bathrooms. Existing bathrooms are adapted to meet the needs of people with disabilities. Improvements are also being made to the social areas of nursing staff and doctors' rooms, which often did not have enough space. The upgrades usually require a reduction in the number of beds within the ward. The emergence of the Covid-19 outbreak has led to additional work in some facilities to introduce locks between general communication areas and wards and to increase the proportion of isolation rooms in the total number of rooms. However, this process is difficult to estimate due to the dynamically changing situation, the lack of uniform standards for the work carried out and the fact that it is being carried out in parallel with other tasks. This issue is the subject for a separate study.

### **6.3. Problems identified**

Based on the facilities surveyed, six main problems were identified, which are generated by an inadequate and perhaps uninformed approach to hospital modernisation by managers, users and contractors.

#### *6.3.1. Lack of a target vision of the whole*

The basic problem that dooms modernisation to failure in advance is a lack of awareness of what the target vision for the hospital is supposed to be. This starts at the level of hospital managers, who do not always have a coherent concept for the development and changes of a particular medical facility. The financial issue often does not allow for the modernisation of the entire complex and forces it to be divided into feasible stages. Leaving this aspect aside, a clear vision of the whole is still crucial to carry out any work in a legitimate and logical manner that will produce a coherent picture. Without this, the consequence is that there is a lack of any connection between the different parts of the hospital related to the phases of renovation carried out at different times. Most noticeable are the contrasting material, colour, functional and aesthetic solutions, which create chaotic and incoherent architecture both inside and outside the hospital. This problem is crucial from the point of view of the comfort of the hospital for patients as well as for staff and other users.

#### *6.3.2. Viewing regeneration partially rather than holistically*

The partial approach to modernising hospitals generates several mutually exclusive solutions that primarily result in financial consequences. In this case, the modernisation of an entire hospital is limited to upgrading smaller parts of the building at certain intervals. This makes financial as well as practical sense, as it gives the rest of the building the opportunity to continue to function. However, with this approach, it is necessary to plan the entire modernisation from the top down, based on plans for the development of the hospital and, further down the line, to establish milestones and divide them into smaller stages.

Unfortunately, in many cases in the hospitals surveyed, the process was reversed. They started with small stages, i.e., for example, the renovation of a bed ward. This was followed by the modernisation of the operating theatre, further wards and thermal modernisation. The result is a collection of separate visions and solutions. What is more, such

a solution results in a lack of coordination, resulting, for example, in the need to modify already renovated parts during subsequent modernisations (Fig. 4).



Fig. 4. Conflicts and problems associated with the partial view of the modernisation. Photo left - mechanical ventilation ducts routed through loggia, across elevation to the roof. Photo right - stairwell partition wall introduced as a result of Covid zoning, limiting the extent of the stair landing and terminating at the location of the glazed existing wall, Puławy, taken by the authors, 2022.

### 6.3.3. Collisions and design errors generated by studies based on incomplete inventories

The period from which the hospitals surveyed originated was the 'pre-computer era'. This fact, and the long time which has passed since these facilities were built, is often linked to the lack of technical hospital documentation. In most of the facilities surveyed, the documentation held was scarce or outdated. Renovations, alterations and adaptations made over the decades, were not often plotted on the hospital plans. Valuable architectural features in many of the examples studied had been obliterated. Undocumented stratification and construction work may contribute to increased conflicts and the need for corrections during the renovation (Fig. 5). It is advisable to introduce, following the example of other regions, a comprehensive assessment system for healthcare facilities, such as the RADAR-HF SW-tool [20].

Under Polish conditions, the funds earmarked for modernisation are not sufficient to carry out an inventor based on the latest measurement techniques, such as laser scanning or photogrammetry, before carrying out a renovation. Consequently, modernisation is most often carried out on the basis of an imperfect and incomplete inventory made using traditional techniques.





Fig. 5. Photo left – a conflict between a partition wall and a window and the need to route ventilation ducts in place of windows. Photo right – an inappropriate routing of ventilation ducts through a window in a patient room, the insufficient distance between bed and wall, Puławy, prepared by the authors, 2022

#### 6.3.4. Difficulties related to the construction of buildings and insufficient dimensions of hospitals



Fig. 6. Photo left - treatment room width too narrow, due to the location of structural walls and the grid of prefabricated columns, new windows not adapted to existing condition (collision with walls). Photo right - disabled toilet, in the middle of which is an enclosed sewer riser from the upper floor, Puławy, prepared by the authors, 2022

The existing building elements are a significant impediment to efficient modernisation and a high-quality end result. Hospitals built in the second half of the 20th century in Poland were most often constructed using prefabricated elements. They were most often characterised by a post-and-beam frame structure with a transverse structural

arrangement and a 60 cm module. The first realisations using this technology date from 1956-1960, with an intensification in the 1970s. While the timber-framed construction is usually a convenience for retrofit works, prefabricated curtain walls with minimal widths of the inter-window zones can be a problem for new interior design (Fig 6).

The biggest problem, however, is the clear height of the storey structure of the buildings surveyed. This is most often 3.0 m; in older buildings 3.3 m. This height, which is often accompanied by localised slopes across the routes (downstand beams – clear height approx. 2.7 m), is insufficient for the proper distribution of the mechanical ventilation ducts (Fig. 7). As a result, the ducts are routed in a stepped manner, and the lack of space for risers inside the building results in the need to place the ducts on the elevation.



Fig. 7. Picture on the left – maximum lowering of the false ceiling to hide the installation ducts above the false ceiling – the result is a room that is too low according to the regulations, with a disturbed scale (quite claustrophobic). Photo right – unusual shaping of false ceilings in place of pull-ups, ventilation ducts routed under the false ceiling, in a conspicuous location, significantly detracting from the aesthetics of the ward, Puławy, developed by the authors, 2022

The hospitals surveyed were built at a time when their functions were very different from those of today and most modern medical, surgical and diagnostic equipment did not yet exist. The standard was usually 4-6 bedrooms without private bathrooms. Nowadays, single and double rooms are the most common; a private bathroom is a matter, of course, in modern hospitals. In the case of existing facilities, the adaptation of patient rooms results in a reduction in the number of beds by up to 50% or more. Consequently, in the hospitals surveyed, at the expense of patient comfort, 4-bedrooms were retained during modernisation, often without a private bathroom. As a compromise, a few 2-bedrooms with a bathroom were designed. Single-bedrooms were rare and most often limited to one isolation room per ward.

Insufficient room space, corridor widths and floor heights present a major design challenge when trying to accommodate modern equipment, particularly diagnostic equipment, such as CT scanners in hybrid operating theatres.

#### 6.3.5. *Surface area of modernisation work carried out*

In the facilities surveyed, a great deal of modernisation was carried out in the wards, often superficially and not including the replacement of infrastructure and installations (especially sanitary facilities), which tend to wear out faster than the building structure itself. More attention is paid to other aspects, such as insulating the building, and replacing joinery and equipment.

Superficiality is also reflected in the choice of materials, which are often of poor quality and wear out much more quickly, greatly reducing both the aesthetics and functionality of the building (Fig. 8). Most frequently, this involves cutting costs without thinking in the long term. Not to mention overlooking aspects, such as the correct choice of colour, material or art elements in the interiors, based on the results of contemporary research, which clearly links these aspects to the level of psychological and physical comfort of patients and staff in the hospital.



Fig. 8. Photo left – no replacement and no changes to plumbing. Photo right – arrangement of the children's ward, made with low-quality materials, without consideration of colour selection, resulting in a chaotic, aggressive and incoherent interior, Puławy, prepared by the authors, 2022

#### 6.3.6. *Lack of respect for valuable architecture*

The lack of conservation protection applies not only to hospitals built after 1945 but also to very valuable pre-war buildings, often examples of functional modernism [21]. For this reason, hospital managers are not obliged to protect existing buildings and adapt modernisation work to them. The consequence of this is a disregard for the aesthetic value of these buildings, the obliteration of valuable architectural elements and the irreversible destruction of cultural heritage (Fig. 9).



Fig. 9. Removal of glazing relevant to the modernistic form of the building in the process of its modernisation - loss of elements that characterise the building, routing of ventilation ducts along the elevation of the building, balconies to be demolished, lack of respect for the historic substance, Puławy, prepared by the authors, 2022

Many hospital facilities are buildings with valuable architecture, but their technical condition or susceptibility to the necessary modernisation changes are very poor. Often, the functional requirements and financial capabilities of hospital managers conflict with the requirements of the conservator of historic buildings, if the building is under such protection [22]. The very fact that buildings are recognised as monuments formally obliges managers, designers and all stakeholders to respect the historic substance and any changes must be agreed upon with the relevant Conservation Officer. It is these formal protection requirements that can determine whether renovations or upgrades are viable or not [23].

The subject of the protection and modernisation of hospitals which are formally recognised as historic buildings (entry in the register of historic buildings or in the municipal records) was extensively addressed by P. Gerber [3]. This mainly concerned buildings dating from the late 19th century, early 20th century and the interwar period. In the case of historic hospitals, P. Gerber points to a multi-faceted analysis of the hospital in question to define whether and to what extent it constitutes something of value that should be preserved in the public interest. He also touches on the modernisation of these hospitals. Even historic hospitals that have been abandoned, with appropriate modernisation work, can once again perform selected medical or other important functions for local communities [24]. In the area under study, there is only one hospital listed in the register of historic monuments still functioning as a hospital (the Vetter Children's Hospital in Lublin) and a few objects included in communal registers of historic monuments (e.g. Lublin, Zamość).

A separate group of facilities are hospitals operating in historic buildings that were originally built as a different function (e.g. Adamopol - a former palace converted into a tuberculosis hospital in 1946, or in Lublin: the former Bobolanum school - now a military hospital, or the Sachs Manor - a Neuropsychiatric hospital). In Poland, this type of transformation took place after 1944, when land ownership was abolished as a result of the so-called agrarian reform. Many nationalised mansion buildings were then converted for social purposes, including health care. It was particularly popular to locate psychiatric hospitals in these buildings. Nowadays, it is problematic to adapt these buildings to modern needs, which is a separate research problem.

It is worth noting the significant differences in the forms and functioning of historic hospitals from the 19th century and early 20th century, and those built after the Second World War. Hospitals from the 20th century are most often not covered by conservation protection, requiring a different design and conceptual approach due to their different structural, material and functional characteristics. They are relatively young buildings, often 50-60 years old, so it is more difficult to estimate their aesthetic and functional value. In the general public perception, buildings created during the People's Republic of Poland, in the style of the so-called socio-modernism, are perceived negatively. In hospitals from this period, designers have to contend with different problems than in hospitals from the 19th century. Here, for example, the corridors are a little wider, but in turn, the storey heights are much lower than in historic buildings, which makes it difficult to install various types of fittings, such as mechanical ventilation.

#### *6.3.7. The approach of hospital managers and users*

In the process of modernising the hospital, a shared and coherent vision for the future of the hospital from the managers is crucial. If they also consider the views of staff and users, then defining this vision can become easier and clearer. It is particularly important to survey the views of staff and patients to find out the comments and possible problems in the different parts of the hospitals. On these issues, too, it is important to have a holistic approach and not to have a dialogue with individual user groups (for example, on one ward) without agreement or interaction with other groups at the same time. A partial approach in this situation can lead to conflicts that will have repercussions for subsequent modernisation processes in individual parts of the facility.

In one of the buildings surveyed, the decision to replace the windows was taken before the changes inside the building had been agreed, and without consulting the users. In the end, all windows were replaced without any coordination with the layout of the rooms and the functional programme of the individual floors. As a result, several problems arose

that could not be solved without replacing the windows again. For example, the original windows had a slightly different form, consisting of 6 parts with a space in the middle of the division to possibly insert a wall between them. This allowed for flexibility and changes in the layout of the rooms. The new windows do not have this space; some of the window sashes directly interfere with the partition walls, making them permanently impossible to open. This also prevents adequate acoustic separation of the rooms, so that, for example, the proximity of a doctor's room next to a treatment room in the paediatric ward makes it very difficult for doctors to work in the office. In addition, the way the windows are opened was not coordinated to suit the layout and arrangement of the rooms. Many more examples of such erroneous decisions can be found, but they are mainly the result of fragmentation, misunderstanding and lack of definition of purpose and vision for the future development of the hospital.

#### **6.4. A clear modernisation process**

Analysing the facilities surveyed, one gets the impression that much of this was carried out mainly by the opportunity to obtain a large grant. A key factor was funding for modernisation or, for example, to make the hospital fit for the Covid-19 pandemic. However, the approach to these changes was most often lacking in the managers' awareness of what their hospital is, what it consists of, what the possibilities for its development are and what it can be after a comprehensive modernisation. It also often lacks forward thinking.

Numerous ambiguities were found in the modernisation processes of the hospitals surveyed, but, despite these, the fundamental issue is what is missing in these processes, and how they can be improved. This would allow the funds received to be used by the modernised hospitals in a sustainable, clear and logical manner, resulting in a well-functioning hospital that is coherent in its concept and form.

A survey of hospitals in the Lubelskie Voivodeship and the authors' own experience, based on their work with selected hospitals, provided an understanding of how modernisation can be approached to make it more effective, but also more efficient.

Based on these experiences, a set of 10 questions has been developed, which hospital managers should answer before embarking on modernisation plans. They are intended to help managers to outline a coherent vision for the development of the hospital, to understand what opportunities, but also constraints, arise from the state of the existing complex, and, with reference to the existing substance and its potential, what changes are required, and what costs are involved. Answering the following questions requires an interdisciplinary approach and, in some cases, preliminary studies (expert opinions, cost estimates, etc.), but will allow an answer to be provided as to whether the modernisation of the existing facilities is justified, whether it will have the intended effect, or whether completely new facilities need to be built.

#### **6.5. Use of contemporary technologies and methodologies to improve the modernisation and operation of existing hospitals**

As the study has shown, traditional measurement techniques for hospitals are not a sufficient method for obtaining pre-design data about the facility. This problem is illustrated by the example of one of the hospitals studied. The design of the modernisation of each ward was done by different designers at different times and without any coordination with the others. Each worked on different floor plan material. This was a result of the lack of

documentation of the hospital, both original and contemporary, which was based on a comprehensive inventory of the building. A comparison of the individual floor plans showed significant differences between the building dimensions. Moreover, the structural elements and ventilation ducts were also not properly inventoried. The biggest problem resulting from this is the collisions which only become apparent at the execution stage, and which increase the cost of the work in an unquantifiable way.

The most sensible solution, in the absence of hospital documentation, would be to use modern measurement methods and BIM methodology. These would allow the facility to be accurately measured using, for example, laser scanning and a digital twin of the facility to be created based on point clouds. Such a model could serve as a basis for the creation of projects for modernisation, reconstruction, etc. and for efficient, coordinated and easier management of the facility and its operation. With such a model, any changes to the facility could be implemented on an ongoing basis. It would also be easier to manage all aspects, including logistics, having an overview of the whole and being aware of what condition each part is in, what it contains and what it requires.

The modernisation of hospitals is an opportunity to improve their functionality from the point of view of users, both staff and patients. The implementation of the principles of evidence-based design (EBD) in the planning of construction works and improvements to hospital facilities is at a high level in the US [25] and Western European countries, but it has not yet been implemented in the Polish healthcare sector. The aspect of modernisation of healthcare facilities does not only concern existing buildings but is also related to the issue of sustainable development, including the adaptation of hospital building certification systems (such as BREEAM, LEED or Green Star) of designed facilities. Considering the life cycle of the building, the designer should anticipate the possibility of the building's vulnerability to change in the future [26]. The vulnerability of the building to these changes is also related to the standardisation of architectural solutions [27].

Tab. 2. Questions to ask yourself before you start planning modernisation. Source: authors.

| <b>10 QUESTIONS BEFORE HOSPITAL MODERNISATION BEGINS</b> |   |
|--|---|
| 1  | What is the vision for the future functioning of the hospital?  |
| 2  | What functional areas will be developed?  |
| 3  | What are the contemporary functional-utility requirements for the developed medical service area?       |
| 4  | What is the technical condition and susceptibility to redevelopment of the existing building?           |
| 5  | Is the existing technical documentation complete and does it include all the changes performed to date? |
| 6  | Does the building have architectural values that should be protected?                                   |
| 7  | Will modernisation, redevelopment, and expansion be required for the planned functions?                 |
| 8  | What are the estimated costs of undertaking modernisation, redevelopment, and expansion work?           |
| 9  | Does the upgraded facility have the possibility to serve another function?                              |
| 10   | Does the existing facility have the capacity to install modern diagnostic equipment?                    |

## 7. Conclusions

It is necessary to take a holistic approach to the problem of upgrading a hospital facility in terms of function, use and energy. Managers should develop investment plans that take into account comprehensive needs and keep the facility database up to date. Efforts should be made to digitise documentation and introduce BIM methodologies and modern

measurement techniques for existing buildings, to better manage the facility and avoid clashes.

The widespread method of selecting contractors for public works contracts should be changed, considering not only price but experience and references. When planning an investment, it is possible to modernise a hospital in such a way as to spend less on it than on building a new hospital - including the expense of demolishing the old building - but this first requires a plan for the whole and moving from the general to the specific.

Only 15% of the hospitals surveyed underwent modernisation, achieving mostly positive functional and aesthetic results. The Independent Public Clinical Hospital No. 4 in Lublin is an example of modernisation (of an unprotected building) with respect for the historic substance and preserving the features of the architectural style in which it was built. The interiors of the entrance area of this hospital use natural materials such as stone and wood, in keeping with contemporary hospital design trends [28]. The Biała Podlaska Domestic Hospital is an example of an impressive transformation of a former infectious diseases ward building from 1940 into a healthcare facility with the character of a care and treatment centre. The transformation consisted of the extension and superstructure of a single-storey block. This is an example of high-level modernization, resulting in a distinctive volume, with corrugated walls that fit well into the context of the site in terms of scale, form, choice of materials and colour (Fig. 10).



Fig. 10. Examples of modernisation done well. Photos on the top – The Independent Public Clinical Hospital No. 4 in Lublin. Photos on the bottom – Stefan Cardinal Wyszyński Voivodeship Specialist Hospital in Lublin (on the left), The Biała Podlaska Domestic Hospital, prepared by the authors, 2022



Many of the hospitals surveyed after modernisation can be described as a success with no peculiarities and no glaring errors. These facilities most often have standard solutions at a cheaper cost, less impressive and faster wear and tear as a result of the operation. Examples of completely uncoordinated modernisation can also still be found, where the result appears to be a series of random decisions. In these cases, errors such as inappropriate choice of colours for the exterior and interior (bright, contrasting colours, patterns), cheap finishing materials, mechanical ventilation and air-conditioning ducts running along the elevation and on the roof are evident and constitute clear elements dominating the mass of the building, disrupting its form, aesthetics and scale (Fig. 11).

Issues relating to the comfort of patients, staff and users in the hospitals surveyed were taken into account to some extent in only a few facilities representing good examples of modernisation. In about 75 percent of the hospitals surveyed, aspects relating to user comfort resulting from the quality of the landscaping of the environment were not taken into account or made up a negligible proportion of the design. An example of this is the design of bathrooms in selected patient rooms. This applies to hospitals in which the modernisation was carried out in a standard or incorrect manner.



Fig. 11. Examples of incorrectly carried out modernisation. Photo on the left – Hospital in Włodawa. Photo on the right – Hospital in Kraśnik, prepared by the authors, 2022

The research shows that the best effects of modernisation can be achieved by taking a far-sighted view of the future of the hospital, making decisions based on a broad rather than a fragmented view of the entire hospital complex. It is also important to strive to use the latest techniques to obtain documentation of the existing state as close as possible to the actual state (laser scanning, etc.). Using the latest surveying techniques may not seem cost-effective, but looking at it in a broader context makes more sense. Carrying out modernisation work on the basis of a good quality inventory can make work easier and quicker and, in particular, avoid many errors and collisions. Looking further ahead, the use of better, but more expensive materials, the inclusion of valuable architectural elements and an overall clear vision of the hospital's development will also significantly contribute to a satisfactory end result and, above all, the improve comfort for patients and staff.

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