DOI 10.1515/gein-2015-0005 GEOINFORMATICA POLONICA
14: 2015

Anna Kochanek

AN ALGORITHMIC FORM OF VERIFICATION OF APPOINTED PHASES OF THE PROJECT DOCUMENTATION FOR A BUILDING INVESTMENT

State Higher Vocational School in Nowy Sącz
annakochanek@op.pl

Key words: the database, the project documentation, the building project, the Zoning Scheme, verification algorithms

Abstract

The process of area development and planning in compliance with conditions outlined in the Zoning Scheme is significant because of the current rapid development of rural and urban areas. The verification of project documentation in terms of observing constant and nationally binding norms, legislation and local laws is based on certain standards. In order to streamline the process of verification undertaken by the relevant public authorities, it is necessary to create formal algorithms that will automate the existing method of control of architecture-building documentation.

The objective of this article is algorithmisation of the project documentation verification allowing further streamlining and automation of the process.

ALGORYTMICZNA POSTAĆ WERYFIKACJI WYBRANYCH ETAPÓW DOKUMENTACJI PROJEKTOWYCH DLA INWESTYCJI BUDOWLANYCH

Słowa kluczowe: baza wiedzy, dokumentacja projektowa, projekt budowlany, plan zagospodarowania przestrzennego, algorytmy weryfikacji

Abstrakt

Proces planowania przestrzennego i przestrzeganie zawartych w Miejscowym Planie Zagospodarowania Przestrzennego (MPZP) warunków jest ważny ze względu na aktualnie dynamiczny rozwój gmin wiejskich i miejskich. Weryfikacja dokumentacji projektowej pod względem zachowania stałych i obowiązujących w całym kraju norm, aktów prawnych i przepisów prawa miejscowego jest oparta na pewnych standardach. W celu usprawnienia procesu weryfikacji dokonywanej przez odpowiednie organy administracji publicznej konieczne jest zbudowanie algorytmów formalnych, które zautomatyzują dotychczasowy sposób kontroli dokumentacji architektoniczno-budowlanej.

Przedmiotem niniejszej pracy jest algorytmizacja procesu weryfikacji dokumentacji projektowej dla usprawnienia i w dalszej kolejności automatyzacji tego procesu.

1. INTRODUCTION

The economic development of country and associated with it demand for new building sites is connected with an increased demand for project services and their analysis in the process of granting a building permit for an implementation of construction investment. A large number of studies of documentation contents stimulates an increase in demand for creating new programs helping people go through a lengthy and arduous process of verification of the project documentation for planned construction projects.

The control of project documentation is currently carried out by officials of architecture and construction administration. In books analysing this situation one can find a severe criticism of this system suggesting that it seriously limits a smooth functioning of the investment process (Anusz 2007).

From the point of view of both an investor and a creator of a project, administrative procedures seem to be very complicated – the waiting time for a decision is very long (Anusz 2008). On the other hand, from the point of view of an official responsible for issuing an appropriate decision, the process of analysis of documentation, due to the very complex and unfortunately often imprecise provisions of Polish law, is tedious and time-consuming (Jędraszko 2008).

The truth is that imprecise legal and administrative procedures contribute subsequently to a number of undesirable situations. There have been cases of issuing permits for the construction of buildings of heterogeneous architecture within the same area. In addition, the lack of an adequate decision support system at the project phase results in a very lengthy waiting time for a building permit. This is due to both the large number of incoming requests and the process of documentation control which is time-consuming and subject to the risk of error during verification of the investment.

In the process of project documentation, it is necessary to distinguish a number of relations between objects describing the purpose of an area of ground, the development line, the spacer relation or the completeness of a projected documentation (Eckes 2007).

Therefore, a computer-aided system of verification of construction projects, uniform for the whole country, is necessary and required. Such a system should be objective and complete; it should likewise assist the human factor.

Achieving this goal is possible by means of use of an adequate and well functioning expert system which, on the basis of strict regulations and an appropriate database, may verify the relations between objects (The Construction Law Act, 1994); it can also verify compliance of a projected building with the law.

2. ASSUMPTIONS ALLOWING ALGORITHMISATION OF THE PROCESS

Preliminary operations to be carried out prior to the analysis of documentation do not in principle require expert knowledge nor specialised software. At the phase of reception of an application, an official responsible for controlling the project documentation makes sure whether the given application contains the necessary documents specified in the Building Law (The Building Law Act, 1994). At the phase of a detailed analysis carried out on the basis of the database created by both experts in the field and engineers and constantly updated in order to comply with the law, all the necessary documents, agreements, statements and opinions contained in the document are thoroughly checked.

The verification of project documentation consists of several steps illustrated in Figure 1.

The suggested algorithms allow a smooth analysis of project documentation devoid of risk of human error.

However, in order to allow the system based on these assumptions to work correctly, it is crucial for the project documentation attached to an application for a building permit to be created in an electronic format, as standard, which allows a flawless interpretation of the data contained in the analysed system.

Currently, almost 90% of the documents prepared by project offices are created in digital format. It is therefore necessary to impose a uniform standard for project documentation and introduce a legislation to help enforce standardisation among creators of projects.

It is assumed that there are the following databases showing:

- relations between projected objects in case of several objects appearing in one investment,
- relations between projected objects and the existing cubature facilities,
- relations between projected objects and the technical infrastructure,
- relations between projected objects and the utilities networks,
- relations between projected objects and other objects,
- areas of analysis carried out upon a projected object (in order to reduce the amount of input data) which depends on many factors such as a type of investment, the area where the investment is planned and others,
- formal and legal requirements that must be met depending on a type of investment.

Databases with pieces of information enabling a comprehensive analysis of geospatial data in the process of verification of the project documentation of a planned construction investment are likewise needed.

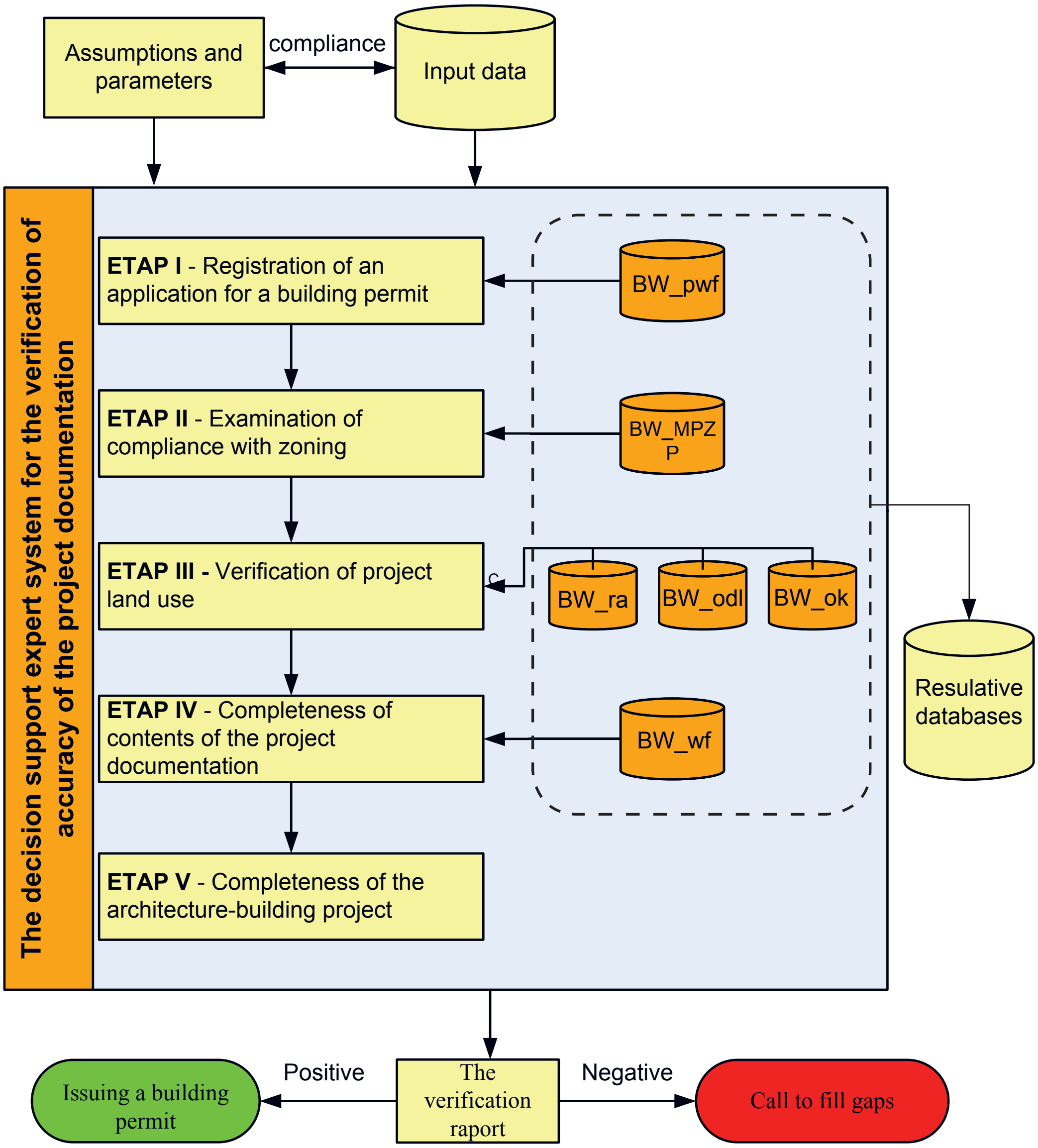

Figure 1. The diagram showing the phases of the decision support expert system for the verification of accuracy of the project documentation**.** Source: Self-reported data

Rys. 1. Schemat przedstawiający etapy systemu wspomagania decyzji dla oceny poprawności dokumentacji projektowej. Źródło: opracowanie własne

So as to carry out a comprehensive evaluation of the documentation, databases containing the following pieces of information are necessary:

- data from the Zoning Scheme,
- data from the Land Information System of the area where the investment is planned,
- detailed data of the building (building types, altitude, data about historic and classified sites),
- data about the land utilities with a possibility of access to the databases of professional institutions allowing to obtain the latest information,
- data about all analysed documentation submitted to the authorities responsible for issuing building permits, containing both detailed pieces of information about the investment per se, the documentation verification process, and possible errors.

Apart from the subsequent phases of the verification process of project documentation, the diagram also includes databases and knowledge bases which are employed by the system while submitting at every phase of the analysis.

3. ALGORITHMISATION OF THE VERIFICATION PROCESS OF THE PROJECT DOCUMENTATION THROUGH THE EXAMPLE OF VERIFICATION OF THE LAND USE INDICATORS

During the phase of checking compatibility of the building construction project with the land development plan of a plot, both the impact of a planned investment upon the neighbouring facilities and fulfilment of the conditions set out in the building code and technical guidelines to be met by buildings and their location, are assessed. A variety of factors – starting with the basic ones: the size of a plot and the land use indicator, the distance between the projected objects and finishing with the relations between the investment and the existing facilities – are verified. The latter factor is of significant importance on account of the fact that an insufficient verification may cause overuse, especially in urban centres, therefore issues of distance and proximity between the investment and the existing facilities should be examined with meticulous care.

Urban indicators indicate the degree of building land use. This condition is observed positively only when all indicators have a value in the range chosen for the given area. None of the indicators used alone provides precise information concerning the spatial characteristics of a building area and, consequently, about its quality as a place to live (Dąbrowska-Milewska 2010).

The indicators of land use are as follows:

- the ratio of footprint to land area (w↓1),
- biologically active surface (B_{as}),
- the development intensity indicator (I).

Figure 2 graphically shows sample surfaces which are illustrated by the examined parameters.

The ratio of the area surface (PN-ISO 1997) to the plot surface is worked out by means of the formula 2.1.

$$w_1 = \frac{P_z}{P_D} \qquad (2.1)$$

where:
P_z – the area surface,
P_D – the plot surface.

It is a constant value for which there are clear guidelines for the ratio of a planned building area to the overall plot surface planned to be the location of the buildings.

The development intensity indicator is defined as the ratio of the total area of all floors of a building to the plot surface, and it is worked out by means of the formula 2.2:

$$I = \frac{P_o}{P_D} \qquad (2.2)$$

where:
P_o – the surface of all floors calculated by means of the outer contour of ceilings, including terraces,
P_D – the plot surface.

The minimum and maximum construction intensity is mandatorily defined by either the Zoning Scheme or a planning permission (The Spatial Planning and Development Act, 2002).The process of determination of the minimum indicator is aimed at the clever use of land for development and the optimisation of construction costs of the urban technical and social infrastructure. On the other hand, determination of the maximum indicator is to protect environmental values and provide the conditions for land use of a specific purpose.

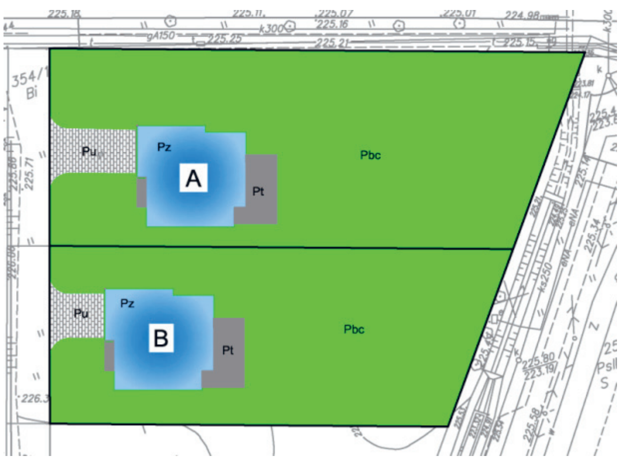

Figure 2. The drawing shows surface indication used for calculating the land use indicators, the details are analysed in the text. Source: Self-reported data

Rys. 2. Rysunek przedstawiający oznaczenia powierzchni do obliczenia wskaźników wykorzystania terenu, szczegóły opisane w tekście. Źródło: opracowanie własne

The current planning practice in the records of the Zoning Scheme and issued zoning conditions typically follows the following guidelines: the maximum permissible percentage of the development of a plot, the minimum percentage of biologically active surface and the height of construction (the maximum or binding in a certain range).

Although it is the basic indicator of land use efficiency, the desired value of the development intensity indicator is rarely determined (Dąbrowska-Milewska 2010).

The last mentioned indicator quantitatively showing the procedure of land use is biologically active surface B_{as}. According to the Act, passed on 12th March 2009, amending the by-law on technical conditions while constructing buildings and their location (the by-law, 2009), biologically active surface stands for an earthen surface area with natural vegetation, 50% of the area of terraces and flat roofs made up of this type of surface, but not less than 10 m^2, and surface water in this area.

Table 1 enumerates the parameters that have been used in the present algorithm of verification of correctness of the indicators connected with a plot planned to be developed in line with the Zoning Scheme.

Table 1. The parameters that occur in algorithms and their meaning. Source: Self-reported data
Tabela 1. Parametry występujące w algorytmach i ich znaczenie. Źródło: opracowanie własne

Parameters used in algorithms		
No.	The name of a parameter	The characteristic of a parameter
	1	2
1	P_pzt	The area development project parameter
2	BD_inw	The database containing pieces of information about a planned investment, regularly updated in the course of process of verification of the project documentation on the basis of which the report is generated
3	P_obpzt$_i$	The parameter of objects located on the plot destined for an investment (cubature objects, green areas, parking areas)
4	BW_MPZP	The database containing regulations of the export system made on the basis of the Zoning Scheme
5	P_strmp$_i$	The parameter informing of the spheres where particular objects are planned
6	P_pko	The sum of surface of all above ground floors of cubature objects
7	W_ipbc	The minimal indicator of surface of a biologically active investment
8	W_wiz	The intensity indicator of development determined on the basis of the Zoning Scheme
9	W_wpz	The maximum surface indicator of development in line with the Zoning Scheme
10	P_wpdz	The plot surface destined for an investment in line with the Zoning Scheme
11	W_iiz	The intensity of investment development indicator
12	P_ipbc	The parameter for biologically active surface
13	W_wpbc	The minimal indicator of biologically active surface in line with the Zoning Scheme
14	W_ipz	The surface of investment development indicator
15	P_ipo	The surface of planned objects – the surface of the ground floor contour
16	P_ipdz	The parameter for the plot surface

For the presentation of algorithms, symbolism suggested by Danuta Zboś in her book "An Introduction to Programming in C" (Zboś 2000) has been used. The keywords are taken from the Pascal programming language syntax. For the presentation of commands in the algorithm, its own notation has been used so as to simplify presentation of the process of documentation verification of the construction projects.

For the control commands (**for, if, then, else, next**) and values (**TRUE, FALSE**) the commonly used English names have been adopted.

TRUE means that the requirements have been fulfilled. Whereas, **FALSE** indicatesthat the requirements have not been met.

Furthermore, the following symbols have been used in procedures:

↔ – it connects with a relation, in other words it performs operations on both sets: compares and analyses.
→ – a specified set of values is determined on the basis of results of analyses and comparisons.
save: P_pzt → {BD_inw}
analyse: {BD_inw} → P_obpzti
/ On the basis of a database about investments {BD_inw}, types of objects located on a plot destined for development P_obpzti were determined */*
analyse: (P_ipdz ↔P_ipo) → W_ipz
/ Calculation of the development surface indicator W_ipz based on surface of a plot destined for development P_ipdz and development surface P_ipo */*
analyse: (P_ipdz ↔ P_ipbc) → W_ipbc
/ Calculation of the minimal indicator of biologically active surface W_ipbc based on surface of a plot destined for development P_ipdz and biologically active surface P_ipbc */*
analyse: (P_ipdz ↔ P_pko) → W_iiz
/ Calculation of the development intensity indicator W_iiz based on surface of a plot destined for development P_ipdz and the sum of all above ground floors of cubature objects */*
save: (P_ipdz, W_ipz, W_ipbc, W_iiz) → {BD_inw}
analyse: ({BW_MPZP} ↔ P_strmp) → P_wpdz
/ On the basis of a database from both {BW_MPZP} and areas where particular project objects are located P_strmp, the minimal possible development surface of a plot, in line with the Zoning Scheme, was determined P_wpdz */*
analyse: ({BW_MPZP} ↔ P_strmp) → W_wpz
/ On the basis of a database {BW_MPZP} and areas where particular project objects are located P_strmp, the maximum surface indicator of development in line with the Zoning Scheme was determined W_wpz */*
analyse: ({BW_MPZP} ↔ P_strmp) → W_wpbc
analyse: ({BW_MPZP} ↔ P_strmp) → W_wiz
save: (P_wpdz, W_wpz, W_wpbc, W_wiz) → {BD_inw}
if:P_ipdz ≥ P_wpdz
  then
  print: the size of a plot destined for an investment is in line with the Zoning Scheme regulations
  else
  print: a plot destined for an investment is too small in comparison with the Zoning Scheme regulations
  print: a project done in violation of the Zoning Scheme regulations
if: W_ipz ≤ W_wpz
  then
  print: the surface indicator of development is within the range of the Zoning Scheme regulations
  else
    print: the development indicator exceeded
  print: a project done in violation of the Zoning Scheme regulations
if: W_ipbc ≥ W_wpbc
  then
  print: the biologically active surface indicator is within the range of the Zoning Scheme regulations
  else
    print: the biologically active surface indicator too low
  print: a project done in violation of the Zoning Scheme regulations
if:W_ipbc ≤ W_wpbc
  then
  print: the surface indicator of development is within the range of the Zoning Scheme regulations
  else
    print: the development indicator too high
  print: a project done in violation of the Zoning Scheme regulations
if:(P_ipdz, W_ipz, W_ipbc, W_iiz) ≡ (P_wpdz, W_wpz, W_wpbc, W_wiz)

/ The verification whether all indicators calculated for the given project investment are in accordance with indicators established on the basis of {BW_MPZP} */*

then

print: the area development plan fulfils requirements set down in the Zoning Scheme

else

print: the area development plan does not fulfil requirements set down in the Zoning Scheme

print: call to fill gaps

print: documentation identified for further analysis

end.

On the basis of data taken from the Zoning Scheme, individual parameters characterising the given investment are determined. The algorithm then calculates the corresponding values which are compared with the indicators required for the given location, determined in a knowledge base. If the requirements of the Zoning Scheme are not met, this algorithm indicates non--compliance.

The presented algorithm represents only one of the problems in the verification process of the project documentation – compliance of the indicators with the values determined in the Zoning Scheme.

This issue has been discussed at length in the author's doctoral dissertation (Kochanek 2012).

4. CONCLUSIONS

The current method of verification of the project documentation is not an easy assignment, nor absolutely reliable. Although the process appears to be straightforward, it requires a wealth of experience in the legal-project and construction business and the substantial degree of concentration at each phase of the verification process. Therefore, the errors arising from a reviewer's inability to maintain a proper level of concentration seem to be unavoidable.

Advances in information technology (IT) provide ample opportunities of employing modern IT tools that would facilitate the process of verification, and at the same time protect the process from a number of errors caused by factors related to the lack of concentration. One of the tools that can speed up the verification process of the project documentation and administrative proceedings related to obtaining the building permit is the expert system, accurately complete with a knowledge base based on the current rules ina spatial planning, project and construction business.

The algorithms presented in the thesis (Kochanek 2012) and the abovementioned example of those algorithms form the basis for creating an expert system making the process of verification of project documentation objective and independent of personal factors.

The main function of the algorithms is to improve the process of analysing and verification of the documentation submitted with an application for issuing a permit for the investment. It should be noted that the use of this procedure not only streamlines operations and shortens the verification process of the project documentation; it also allows one to eliminate most of the errors that can occur in the process caused by the human factor (resulting, for example, from the monotony of their operations).

The verification of construction projects is often a very laborious and lengthy process. The rationalisation of this process will bring considerable elementary and qualitative benefits.

5. WORKS CITED

[1] Anusz S., 2007: *Doświadczenia monitoringu planowania przestrzennego*. Roczniki Geomatyki, t. V, z. 7, PTIP, Warszawa

[2] Anusz S., 2008: *GIS a koncepcja przestrzennego zagospodarowania kraju*. Roczniki Geomatyki, t. VI, z. 3, PTIP, Warszawa

[3] Dąbrowska-Milewska G., 2010: *Standardy urbanistyczne jako narzędzie racjonalnej gospodarki terenami w mieście*. Wydawnictwo Techniczne Politechniki Krakowskiej, Kraków

[4] Eckes K., 2007: *Kontrola obrazu mapy wielkoskalowej w systemie eksperckim. Główne problemy współczesnej kartografii. Kartograficzne programy komputerowe. Konfrontacja teorii z praktyką*. Wydawnictwo Uniwersytet Wrocławski, Instytut Geografii i Rozwoju Regionalnego, Zakład Kartografii, Wrocław

[5] Jędraszko A., 2008: *Gospodarka przestrzenna w Polsce wobec standardów europejskich*. Biblioteka Urbanisty, t. XVIII. Urbanista, Warszawa

[6] Kochanek A, 2012: *Analiza jakości danych geoprzestrzennych w procesie weryfikacji dokumentacji projektowych inwestycji budowlanych z wykorzystaniem systemu ekspertowego*. Rozprawa doktorska, AGH, Kraków

[7] Kochanek A., Wolski B., 2012: *Weryfikacja normatywnej zgodności projektów budowlanych.* Akademicka Oficyna Wydawnicza EXIT, Warszawa

[8] PN-ISO 9836, 1997: *Obliczenie kubatury i powierzchni budynków i budowli*. WACETOB, Warszawa

[9] Rozporządzenie Ministra Infrastruktury z dnia 12 marca 2009 r. *zmieniające rozporządzenie w sprawie warunków technicznych, jakim powinny odpowiadać budynki i ich usytuowanie*.(Dz.U. z 2009 r. Nr 56, poz. 461)

[10] Ustawa *o planowaniu i zagospodarowaniu przestrzennym* z dnia 27 marca, 2003c r. (Dz.U. z 2003r. Nr 80, poz. 717 z późniejszymi zmianami)

[11] Ustawa *Prawo budowlane* z dnia 7 lipca 1994r. (Dz.U. z 1994 r. Nr 89, poz. 414 z późniejszymi zmianami)

[12] Zboś D., 2000: *Podstawy programowania w C. Podręcznik dla studentów wyższych szkół technicznych*. Wydawnictwo Politechniki Krakowskiej, Kraków