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UML – a survey on technical university students in Lublin

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Abstract. Unified Modeling Language (UML) is a commonly known OMG (Object Management Group) standard for designing software systems. However, practice shows that the usage of UML varies depending on the specificity of a software system and company. The authors decided to explore the perspective of students with experience in using UML by conducting an exploratory survey with them. Analysis of the data gathered revealed that they use UML diagrams as an additional help when developing software. The main risk turned out to be different diagram interpretations. At last, the main motivation to learn UML was obtaining a credit at university.

Keywords: UML; software engineering; information systems modeling; survey

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UML – punkt widzenia studenta uczelni technicznej w Lublinie

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Streszczenie. Unified Modeling Language (UML) jest powszechnie nauczanym i stosowanym standardem Object Management Group (OMG) służącym do opisu systemów informatycznych. Jednakże praktyka pokazuje, że użyteczność UML waha się w zależności od specyfiki projektu i systemu informatycznego. Autorzy zdecydowali się przeprowadzić ankietę badającą opinie studentów, mających styczność z językiem UML, na temat wykorzystania wykonanych w nim diagramów. Analiza zebranych ankiet wykazała, że diagramy UML pełnią zazwyczaj rolę pomocniczą, głównym ryzykiem ich użycia są różnice w ich interpretacji, a główną motywacją do nauki jest uzyskanie zaliczenia na uczelni.

Słowa kluczowe: UML; inżynieria oprogramowania; modelowanie systemów informatycznych; ankieta

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1. Introduction

Unified Modeling Language (UML) is a widely taught and applied Object Management Group (OMG) standard for the description (modeling, design) of IT systems. One of the main goals of its creation is to support the IT industry by providing a graphical general purpose modeling language, which could be used for business process modeling, as well as analysis, design, documentation and implementation of IT systems. It is used in such areas as banking, healthcare, aerospace, etc. Particularly interesting is the last field, where it is used to simulate and ensure the security of complex real-time systems. Such a specificity of applications requires appropriate standardization and interoperability of UML, which has been achieved, among others, by the formal definition of the metamodel using MOF, the technology-independent definition of semantics, as well as user-oriented syntax. [10]

UML is a constant element of the color of the industry that deals with aspects of producing all kinds of software, ranging from universities to enterprises. It is worth mentioning a study [8], in which UML is indicated as the most commonly used modeling language by university employees and software companies. It is also worth quoting M. Petre [6], who is quite critical of the universality of UML, but the way it is discussed confirms the important role of UML and its existence in the awareness of the IT community. Nor can it be denied an important role in model-driven engineering, although not all types of diagrams are used.

Issues of UML applications in IT projects have already been raised by other authors. Some characteristic works are presented below. In [4], two methods of modeling IT systems, based on user stories and UML, are compared, and a ranking of diagrams created in terms of the degree of use. The results shown partly coincide with the findings described in this article. In [2], research on the use of particular UML diagrams is presented, and what is particularly valuable is the question of the reasons for their non-use. The authors also point out that diagrams may be ambiguous in their interpretation, and their misunderstanding may constitute a significant barrier to their use. [5] describes research on the usefulness of specific UML diagrams in open source projects (10 such projects are included). It turns out that class diagrams are used most often, and much less frequently use case diagrams and activity diagrams. In [7], the results of surveys on the knowledge of UML diagrams, the source of knowledge about them and the objectives of their application are presented. The authors have compiled the data in terms of gender and job title. In [9], the concept of a lighter version of UML is discussed. According to the researchers, students learning UML are overwhelmed by the excessive complexity and multitude of different diagrams. A particularly interesting work is [1] – it is a compilation of studies on the use of UML over the past 15 years. The author addresses the issues of effectiveness, profits and costs of UML use, as well as the correctness of the research methodology. The results of examination with an eye-tracker are also presented. Finally, in [3], the authors conduct a thorough research, posing important questions about the degree of adoption and the adequacy of UML diagrams to the code in open source projects. Of note is a relatively small percentage (about 1/3 of cases) where the UML model has been implemented in its entirety, without any changes. The authors also discuss the real help provided by diagrams for new employees and how diagrams help in the implementation of an IT system.

Literature analysis has shown great interest in the subject, which is dictated to a large extent by UML popularity in production of IT systems. In our opinion, it is worth exploring the perspective of technical university students who have contact with the UML language during their studies or professional work. This publication is a kind of insight into the state of the Lublin market, and the conclusions can serve as a guide for those who teach subjects thematically related to software engineering.

2. Study aim and methods

In view of the above, it was decided to carry out an exploratory survey whose questions were grouped in the following categories: profile of respondents, professional experience, UML diagram skills, attitude towards UML diagrams. The results and the questions will be discussed in the next chapter.

The following research questions were formulated:

RQ1. What is the main motivation for students to learn UML?

RQ2. Are UML diagrams frequently used?

RQ3. What are the challenges and opportunities when using UML?

The survey was then disseminated to technical university students in Lublin who learned the UML language. Although the geographical scope of the survey was local, one should not ignore the globalization of thoughts, ideas and the process of software development within IT enterprises. Nevertheless, authors of this article do not intend to generalize the results of survey on the whole population.

3. Research results

This chapter presents the results of the survey, which was answered by 79 people. The survey was started in 2018.

3.1. Education and professional experience of respondents

Almost two thirds of the respondents completed first degree studies (50 people). One third of the respondents was finalizing second degree studies (26 people). The survey was also attended by 3 people who had not yet obtained a university degree, although had a commercial experience in IT. All persons declared studies in computer science or a related course of study.

As a rule, people participating in the survey had a low experience in the IT industry: 24 people were employed for one year, 13 people for 2 years, 7 people for 3 years, 7 people for 5 years. The remaining people did not provide such data in the survey.

Over 12% of respondents (10 people) declared lack of contact with commercial IT projects. They were excluded from further analysis of professional experience of respondents. An IT project is understood as a process of an IT system development basing on the requirements of the person who ordered its creation. Most of the respondents participated in 1-3 commercial projects (42 people). In general, a large percentage of respondents is professionally active, which is typical for the IT industry. See Table 1.

Table 1. Number of commercial projects in which respondents participated

Number of projects	Number of respondents	Percentage of respondents
0	10	12.7 %
1	10	12.7 %
2	16	20.3 %
3	15	19.0 %
4	6	7.6 %
5	5	6.3 %
6	3	3.8 %
7	1	1.3 %
8	1	1.3 %
9	5	6.3 %
>9	7	8.9 %

Table 2 presents a typical size of a team developing an IT system in which the respondent participated. It should be noted that the most frequently (24 times) indicated number concerned 3-8 people, while 17 indications referred to the number of 8-10 people. The results presented in Table 2 may be influenced by the respondents' small professional experience, as well as the specificity of modern software development methodologies, e.g. Scrum.

Table 2. Typical number of project team members

Typical size of the team	Number of respondents	Percentage of respondents
1-3 persons	15	21.7 %
3-5 persons	12	17.4 %
5-8 persons	12	17.4 %
8-10 persons	17	24.6 %
>10 persons	13	18.8 %

Table 3 presents a summary of responses for which business sectors (more than one could be indicated) the respondent usually participates in software development. The sectors that clearly lead the way are: medicine, telecommunications, trade, transport and finance. Other sectors include: catering, clothing, politics, law and legislation, energy, entertainment and game development. Moreover, on the basis of the survey results, it can be concluded that the most frequently mentioned business sectors employ students who declared good theoretical knowledge of UML diagrams. However, only half of the respondents admit that they use these diagrams in practice.

Table 3. Software development by business sector

Sector name	Number of responses	Percentage of respondents
Medicine	18	26.1 %
Telecommunication	12	17.4 %
Economy	13	18.8 %
Trade	16	23.1 %
Transport	14	20.3 %
Finance	18	26.1 %
Others	20	29.0 %

3.2. Knowledge of UML diagrams among respondents

In this section, the analysis did not exclude respondents who declared a lack of commercial experience.

Table 4 shows which UML diagrams are known among respondents. Each respondent could indicate more than one diagram. The diagram of particular type is known to a person, when the person is able to read and create it. The most commonly known were use case and class diagrams. This may be due to the fact that the specificity of their construction is conducive to easier programming of IT system modules. The next places were taken by activity and sequence diagrams, and finally package, component and state diagrams.

Then the respondents were asked to indicate the diagrams they used in IT projects. The most frequently indicated were use case and class diagrams – almost half of the respondents. The following places were taken by activity, component, state, sequence and package diagrams. Numerical values seem to confirm the result of literature analysis, which states that the knowledge of diagrams does not go hand in hand with the universality of their use. Details can be found in Table 5.

Table 4. UML diagrams known to respondents

Diagram name	**Number of responses**	**Percentage of respondents**
Class	55	69.6 %
Use case	53	67.1 %
Sequence	38	48.1 %
Activity	35	44.3 %
Component	25	31.6 %
State	22	27.8 %
Package	18	22.8 %
Others	0	0.0 %

Table 5. UML diagrams used by respondents

Diagram name	**Number of responses**	**Percentage of respondents**
Use case	24	30.4 %
Class	19	24.1 %
Activity	16	20.3 %
Component	9	11.4 %
Sequence	7	8.9 %
State	7	8.9 %
Package	4	5.1 %
Others	0	0.0 %

Respondents also indicated the most frequently used editors to create UML diagrams. Table 6 contains a list of them. Visual Paradigm was the most popular. This may be caused by its availability at universities (graduates additionally transfer their habits from studies to professional work), as well as a high degree of compliance with the UML standard published by OMG. The second most important editor was Microsoft Visio, which is quite puzzling considering the specificity of its work. Perhaps the good result is caused by its availability. A high position of Microsoft Visio was also noted in study [8]. It is worth noting that modeling capabilities integrated with programming environments, such as Eclipse and NetBeans, are not used very much. Others category included StarUML and Enterprise Architect.

Table 6. Editors used to create UML diagrams

Editor name	**Number of responses**	**Percentage of respondents**
Visual Paradigm	31	39.2 %
Microsoft Visio	11	13.9 %
PlantUML	4	5.1 %
yEd	4	5.1 %
UML plug-in for Eclipse	2	2.5 %
UML plug-in for NetBeans	2	2.5 %
UML plug-in for IntelliJ IDEA	2	2.5 %
draw.io	2	2.5 %
Others	4	5.1 %

The main motivation for learning how to create UML diagrams was indicated as: obtaining a credit at university (70.1% – 56 people), acquiring skills necessary for professional work (12.7% – 10 people) and the need for self-development (6.3% – 5 people). 8 people (10.1%) were not interested in learning UML. The main motivation for learning was to complete the course; however, the knowledge of UML, although to a lesser extent than it is taught at universities, is useful when working on commercial projects of IT systems.

3.3. Opinion of respondents on UML

In this section, the analysis did not exclude respondents who declared a lack of commercial experience.

First of all, it was asked to what extent UML diagrams support the implementation of IT systems. The range of the scale of assessments was from 1 (useless) to 5 (necessary). The results are presented in Table 7. It may be stated that the respondents have different opinions on the usefulness of UML diagrams in designing IT systems. On the one hand, 30 people (38.0%) indicated high usefulness (grades 4 and 5), however, 41 people (51.9%) declared average usefulness (grades 2 and 3). Certainly, it can be seen that there is a certain dissonance between the theory of software engineering and good practices of software modeling, and the practice applied in IT companies. In addition, it may be suspected that this is a symptom that the failure to attach importance to the UML diagramming does not have a significant negative impact on the IT systems development. This is also noted by the authors quoted in the literature review.

Respondents were then asked whether they see benefits of using UML diagrams. 14 people (17.7%) said that UML diagrams were not beneficial and unnecessary. 21 people (26.6%) said the benefits were high. As many as 44 (55.7%) believed that the benefits were only minor. This may be due to the amount of time and resources needed to create UML diagrams. The second reason may be the scale of the projects the respondents work on. If it is a small team (2-5 people), the diagrams will not be as important. Another case is large teams (50-100 people), where people are divided into groups dealing with specific aspects of the IT system. Then UML diagrams help to illustrate the expectations towards particular groups and the software created.

Table 7. Assessment of the extent to which UML supports software development

Grade	1	2	3	4	5
Number of responses	8	20	21	24	6
Response rate	10.1 %	25.3 %	26.6 %	30.4 %	7.6 %

The next issue concerned the problems with creating UML diagrams. It turned out that 21 respondents (26.6%) noticed problems with creating diagrams even in people with long working experience. 20 respondents (25.3%) noticed such problems in people with low work experience, while 20 people (25.3%) did not notice that anyone around them had problems with creating UML diagrams. 18 people (22.8%) did not comment on this issue.

The respondents were then asked whether they consider UML diagrams to be clearly interpretable. As many as 47 respondents (59.5%) said they had problems interpreting UML diagrams in an unambiguous way. 24 people (30.4%) noticed that each person creates their own style and after understanding it the diagrams become unambiguous. A small number of respondents (10.1% – 8 people) stated that there was no problem with interpreting UML diagrams unequivocally from the start.

In response to the question whether UML diagrams reduce the risk of errors, more than half of the respondents (57.0% – 45 people) were willing to believe in the positive impact of UML diagrams on error avoidance. Every fourth person (24.1% – 19 people) believed that these diagrams had little impact. Only 10 people (12.7%) said that diagrams were important to avoiding making mistakes, while 6 respondents (7.6%) were convinced that there was no connection between the two issues.

Finally, respondents were asked if they believe that UML diagrams shorten the time of project implementation. Most of the respondents (51.9% – 41 people) were not sure about the impact of UML on saving time during project implementation. Every third opinion maker (34.2% – 27 people) was convinced of the positive impact of UML. In turn, 11 people (13.9%) said that UML diagrams had no significance in this respect.

4. Summary

The survey showed that UML diagrams are used in IT projects, but this is not the rule. People have different views on how to use them, but generally there is no common belief in their usefulness. They are often treated only as additions or are replaced by hand-written diagrams or diagrams in other notations, including informal ones. In addition, some respondents said that no diagrams were needed, a verbal description being enough. (RQ2)

According to the majority of the respondents, a broad knowledge of UML diagrams is necessary, first of all in order to be able to obtain a credit at university. In a professional career such broad knowledge is not always necessary, because, as shown by the survey, UML diagrams are not always used regularly in companies. (RQ1)

The results also showed that according to most respondents, the interpretation of UML diagrams is not clear and that designing systems with their help does not have any impact on a significant reduction in the risk of errors and acceleration of work on the implementation of the project. This also translates into a reduction in the frequency of using UML diagrams in IT projects and their frequent treatment as redundant, because they do not really contribute much to the project. (RQ3)

At last it cannot be forgotten that opinions gathered during the survey originate from persons with relatively low commercial experience and related to the Lublin region. Thus this paper only shows their perspective on using UML during a software development process, that not necessarily fully complies with the IT industry reality.

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