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## INFORMATION SYSTEMS

and their role in the sustainable  
development of an organization

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# *EDITORIAL*

## *Information Systems and Their Role in the Sustainable Development of an Organization* \_\_\_\_\_

\_\_\_\_\_ ***Prof. Asoc. Dr. Arben DUSHI*** \_\_\_\_\_

EDITOR IN CHIEF

With the rapid evolution of the business landscape, organizations are increasingly recognizing the significance of sustainable development. Embracing environmentally responsible practices and social stewardship helps organizations fulfill their corporate social responsibility and contributes to long-term profitability and growth. Information Systems (IS) play an important role in driving sustainability efforts within an organization and are very important in promoting sustainable development and can enhance organization's sustainability initiatives.

One of the fundamental roles of Information Systems in sustainable development is data collection and analysis. IS enables organizations to gather and process vast amounts of data related to their environmental impact, resource consumption, and social responsibilities. By utilizing sophisticated data analytics and reporting tools, organizations can identify areas of inefficiency and set performance metrics for their sustainability goals. IS aids in the efficient allocation of resources, reducing waste and minimizing the ecological footprint of the organization and plays a pivotal role in optimizing energy and resource consumption. Smart metering, building automation systems, and energy management software allow businesses to control their energy usage in real-time.

Sustainable development also encompasses the entire supply chain of an organization. Information Systems can facilitate transparency and traceability

across the supply chain. This allows organizations to identify environmentally friendly suppliers, assess social compliance, and promote ethical sourcing practices, enhancing the overall sustainability of the organization's products or services. IS enables organizations to conduct comprehensive environmental impact assessments. By using geographic information systems (GIS) and other tools, organizations can analyze the way their operations affect the surrounding environment. Consequently, they can make informed decisions to mitigate negative impacts and develop sustainable strategies.

Sustainability reporting has become a norm for responsible organizations. Information Systems play a vital role in streamlining the reporting process, ensuring accuracy, and tracking progress towards sustainability goals. Additionally, IS assists organizations in complying with environmental regulations and industry standards, reducing the risk of non-compliance penalties.

IS facilitates effective communication with various stakeholders: customers, employees, investors, and the public. Organizations can use online platforms, social media, and sustainability dashboards to share their sustainability initiatives, achievements, and future goals. Transparent and proactive communication fosters trust and loyalty among stakeholders, reinforcing the organization's commitment to sustainable development.

Information Systems enable real-time monitoring of sustainability performance. Regular assessments and benchmarking against industry standards allow organizations to identify areas that need improvement and refine their sustainability strategies continuously. The role of Information Systems in the sustainable development of an organization cannot be overstated. IS provides the tools and insights necessary to make informed decisions and achieve long-term environmental and social objectives. Embracing Information Systems as a core element of sustainability initiatives empowers organizations to create a positive impact on the environment, society, and their bottom line, ensuring a brighter and more sustainable future everybody.



# Software development using design patterns

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**MSc. Aurela KALLJA**<sup>1</sup>

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ADVISOR: PROF. DR. PETRAQ PAPAJOJGI

## Abstract

*Information systems have become an integral part of our lives. The demands for software that help us accomplish our daily tasks are ever increasing, considering the great technological momentum around the globe. Software engineering is the process of analyzing user requirements, designing and developing software applications. Each user request is a problem that an individual or a business has encountered in the daily work processes.*

*The goal of software engineering is to provide an optimal and efficient solution to these problems to increase the overall productivity of employees in the respective industries and at the end of the day, to increase profits. Providing these solutions is no easy feat, as the problems are often complex and in addition to requiring careful analysis, they also need smart solutions. Fortunately, we have the ability to learn from experience and apply our knowledge in different contexts to achieve our goals. As in any field of life, problems have a recursive nature and it often happens that the same problem is encountered in different contexts. Naturally, we can think that similar problems have similar solutions. The set of solutions to general software design problems in a specific context constitutes what are called design patterns. Design patterns are structures of how some objects dialogue with each other to provide a specific solution to a problem. They are ready-made solutions to known problems,*

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<sup>1</sup> Aurela Kallja has a background in both economics and computer science. In 2020, she is graduated in “Business Informatics” at the European University of Tirana. In 2022, she is graduated from the European University of Tirana with a Master of Science degree in “Software Engineering”, profile “Data management”. During her studies, Aurela demonstrated a passion for technology and a strong drive to learn, as evidenced by her completion of a “Java” course at SDA, where she acquired valuable programming skills. Currently, she is working online as a QA testing engineer.



*and the real challenge with them is not in their construction, but in the intuitive ability to associate a design problem with the corresponding pattern that offers the most optimal solution. This paper will deal with the development of an information system for an ATM Exchange system, which carries the functionalities of an ATM cash machine and exchange rate chart. The development of this software will be totally based on design patterns, more specifically “Observer” pattern and “Chain of responsibility” pattern. This paper aims to emphasize the advantages of using design patterns and highlight the potential of them to solve general problems in a specific context. It also focuses on software engineers, information systems developers and software engineering students. This paper will serve as a manual of best software development practices, emphasize the principles of flexibility and reusability of information systems development components.*

**Key words:** ATM, design patterns, exchange rate, software engineering, system, OOP.

## **Introduction**

Information systems have significantly improved the productivity of human activity from the moment of their appearance until today, when it is difficult to imagine any area of life without software systems that make everything easier. Nowadays, software systems have been perfected so much that with their help, processes that were impossible to carry out a few decades ago, nowadays can easily be carried out. All this thanks to the improvement of software development techniques, driven by the need to provide solutions for problems of complex natures because, the more complex the problem, the more complex is the provision of adequate solutions. As each problem is specific in its nature and requires a specific software solution in order for the information system to meet expectations.

The science that deals with the study and analysis of requirements for a certain software development problem, the design and development of solutions is known as software engineering. In software engineering “Design patterns are descriptions of communicating objects and classes that are customized to solve a general design problem in a specific context.” (Gamma, Helm, Johnson, & Vlissides, 1994).

Design patterns enable us to solve complex problems in a fast and efficient way with the guarantee that the solution has been tested and proven thousands of times throughout the history of software development and has proven to be efficient.

“Each pattern describes a problem that occurs repeatedly in our environment, and then describes the essence of the solution to this problem, in such a way that this



solution can be used a million times, without ever doing it the same way twice.”  
(Alexander, 1977)

A design pattern names, abstracts, and identifies key aspects of a common design structure, making it useful for creating reusable object-oriented designs. These models identify the participating classes and instances, the role and relationships between them, and the distribution of responsibilities. In this paper, in addition to the theoretical elaboration of how design patterns work and how developers benefit from them, an information system based on design patterns, specifically “The Observer” pattern and “The Chain of responsibility” pattern, will be developed.

### *1.1 Purpose*

Some of the goals of this paper are:

- Introducing an information system based on the principles of object-oriented programming. More specifically, the aim is to build an ATM cash machine system, using “The Chain of responsibility” pattern, and “Observer” design patterns.
- To represent the facts which state that design patterns are the optimal solution for the problems that are often encountered in an information system and to implement them correctly.
- By enabling an efficient interaction for the user, the ATM and the system administrator, I will aim to develop a service that is characterized by: transparency, security and simplicity of use of the solution provided.

### *1.2 Objectives*

The objectives that I intend to reach at the end of this paper are:

- Creating a model through the application of a set of explanatory and heuristic principles.
- Understanding a problem in details in terms of its processes and concepts, through the study and application of the information and techniques presented.
- Creation of an information system using design patterns, such as Observer and Chain of Responsibility patterns.
- Designing a solid solution through the use of Object-Oriented Programming principles.

### *1.3 Methodology and results*

The software industry is a fast-paced field and innovation is at a crazy pace compared to other industries. As in any other industry, the key to success is the ability to innovate before anyone else. Based on these indications, we assume that a commercial bank intends to launch ATMs that, in addition to playing the role of cashier, also provide information and functionality related to the exchange rate. Such a system, which is offered for the first time, should be able to provide citizens with real-time teller services that include managing their money, withdrawing money at any time as well as information on the exchange rate in every moment. The system must be flexible, update data in real time with exchange rate changes in international exchanges market, as well as support the removal or addition of new currencies, the creation and updating of accounts in different currencies, and updating the current status of ATMs.

## **Elaboration**

### *2.1 Development of the model by means of UML*

Based on the requirements, the system will be developed using abstraction to define the concepts that participate in the ATM Exchange system. The design of UML software model has been carried out too. The purpose of using the model is to get a good understanding of the system that will be built. The three models that were used to design the ATM Exchange software are Use case diagram, Class diagram and Sequence diagram. Model development, in addition to creating a visualization of the developing system, helps us generate a significant amount of code correctly.

### *2.2 Use Case Diagram*

To create a software product, the developer must know how the user will interact with the application. This is where we need the Use Case diagram. A Use Case Diagram summarizes the details of the users and their interaction with the system. It specifies the expected behavior of the system (what?), rather than the exact method of achieving it (how?). A key concept of using these diagrams is that they help create a system from the end user's perspective. It is an effective technique for communicating system behavior in user terms by specifying all externally visible system behavior.

“Use Cases represent only the functional requirements of the system. Other requirements, such as business rules, quality of service requirements, and implementation constraints should be represented separately, with other UML diagrams.” (What is Use Case Diagram?, 2022).

### USE CASE DIAGRAM



The ATM Exchange software system contains two main actors: the user and the administrator. The user or rather the client has the functionality of logging into the system and then he can perform a series of operations. These operations include: checking the balance in real time, withdrawing money and obtaining information on the exchange rate. Another important actor is that of authentication. The authentication actor plays an important role in validating the credentials that are inserted into the system. This functionality serves both the client and the administrator and is a key factor that ensures the security of the information system.

The administrator is another actor, who has associated several use cases in the ATM Exchange system. The administrator can log into the system and after his data goes through the authentication process, he has a series of menus available, which include account management, ATM management and exchange rate management.

Account management involves adding new accounts to the system for new customers, updating account information of existing customers, and finally deleting the accounts of customers who are no longer served.

ATM management includes adding new currencies, updating existing currencies and deleting currencies that are no longer serviced by the system. Another use case of the administrator, which contains several sub-cases, is currency management. This use case includes adding a currency rate, updating a currency rate, and deleting a currency rate.

### 2.3 Class Diagram

A class diagram is used to address the static view of a system, the relationships between classes, and how concepts relate to each other to form the whole, which is the system being built.

“In software engineering, a Class Diagram in UML represents a type of structural diagram that describes the structure of a system by showing the system’s classes, their attributes, methods, and relationships between objects.” (What is Class Diagram?, 2022)

CLASS DIAGRAM



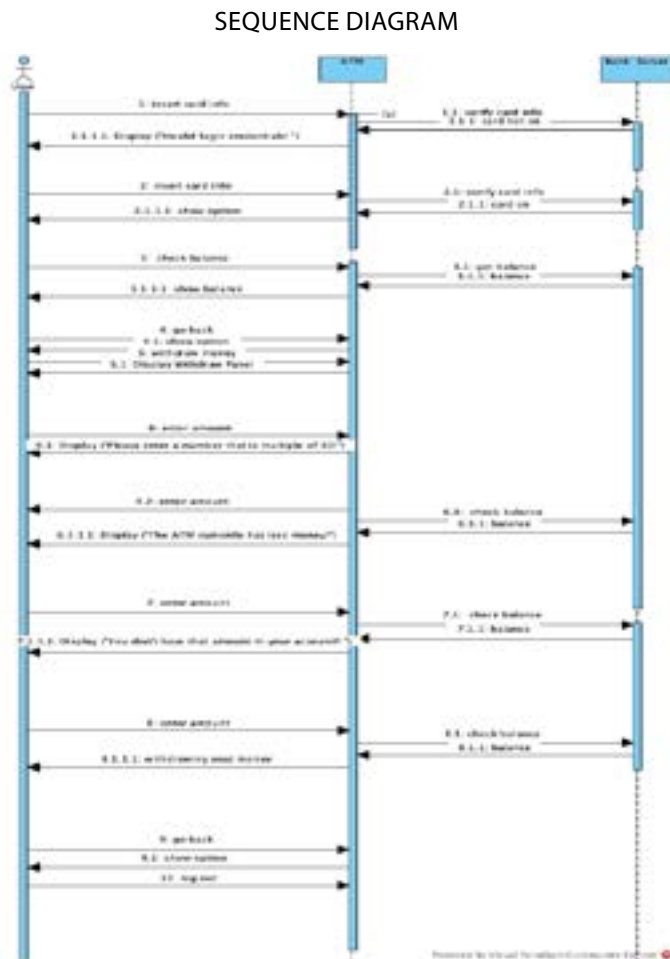
There are eight classes and two interfaces that participate in the information system, which have been defined based on the analysis of abstraction. The main class in the UML diagram of the system, which plays the role of the main class in the information system, is the `ExchangeAtmFrame` class, which has navigable association with the two interfaces, the `Observer` and the `DispenseChain`. The `Observer` interface is implemented by three classes `BaseRate`, `BuyRate` and `SellRate`. In this class diagram we have two pure uses of the principle of polymorphism implemented through the use of interfaces, which is a very powerful feature of object-oriented programming and the Java language in particular. The three classes `BaseRate`, `BuyRate` and `SellRate` realize a polymorphic implementation of the `Update()` method defined in the interface. But polymorphism is not limited to the implementation of a single method. The `DispenseChain` interface is implemented by four classes that are `Currency100dispenser`, `Currency50dispenser`, `Currency20dispenser`, `Currency10dispenser`, which implement the two methods defined in the `DispenseChain` interface: `setNextChain()` and `dispense()`.

## 2.4 Sequence Diagram

The sequential diagram shows the execution of the system based on user cases, but in chronological order. In simple words, the sequence diagram represents user cases by the time they occur.

“A sequence diagram represents the objects that participate in the interaction in a timely manner. The timing of when messages are sent to objects is important and changing this order can lead to unexpected results.” (Petraq J. Papajorgji, Software Engineering Techniques Applied to Agricultural Systems, An Object-Oriented and UML Approach, 2014)

Figure below shows the sequence diagram of the ATM Exchange software.



## *2.5 Design Patterns used in system development*

The development of the ATM Exchange system is based on object-oriented programming technology. This object-based approach presents an information system as a community of objects that are in constant communication with each other with the goal of fulfilling the functions that the system has. The interaction between objects is realized by the behavior of each object and through the impact that the behavior of each object has on itself or on other objects, it affects the state of the object. The interaction of objects between each other adheres to a structure or a pattern. From here we come to the concept of design patterns, which are structures that represent the way objects interact with each other to provide solutions to a general problem in a specific context. So, if the information system is a bunch of objects that communicate together, a design pattern describes the flow of execution of this communication that coincides with the solution of a certain problem. In the development of the ATM Exchange system, two general design problems were identified, which were solved using the Chain of responsibility pattern and the Observer pattern. In the next subsection, it will be explained how these patterns are implemented in the system and why exactly these patterns were chosen.

## *2.6 Chain of responsibility as a pattern for ATM functionalities*

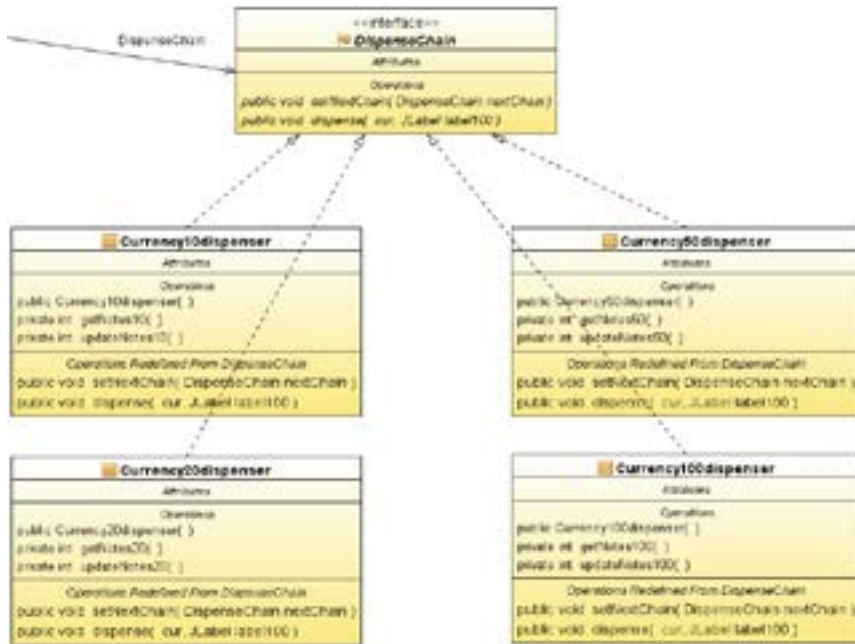
One of the functional requirements of the software we are developing is the functionality of an ATM cash machine. But what is the role of an ATM cash machine? Most of us, have had the opportunity to use an ATM to withdraw money or check the balance in our account. The balance check process is a simple read-only process. While ATM withdrawal is a functionality which enables the user to provide an amount to withdraw and withdraw it. But since it is an automatic service, there are some restrictions, the two main ones being that the amount must be a multiple of ten and the withdrawal is made in regular denominations that include tens, twenties, fifties and hundreds. The system calculates the amount and determines the deductions the user will receive. The selection of denominations is determined based on the amount given by the user and the availability of denominations in the ATM. This determination occurs through the design pattern of the chain of responsibility.

“Chain of responsibility avoids piling up requests to one receiver by giving more than one object the opportunity to manage the request. It creates a chain between receiving objects and passes the request along the chain until an object handles it.” (Erich Gamma, 1994).



Figure below shows the UML diagram of the “Chain of Responsibility” design pattern for the ATM Exchange system. This diagram consists of an interface that has two methods defined, one for passing request management from one object of the chain to another, and another that performs request management.

CLASS DIAGRAM OF THE CHAIN OF RESPONSIBILITY” PATTERN



As shown in the figure, the chain consists of four objects, which are responsible for managing requests to the object chain. In this case we have a chain, which has one object for each denomination. Now, the user makes a withdrawal request with a certain amount, if the amount is above the value of 100, the chain starts from 100 and passes in turn to the objects of other values until the withdrawal amount is met and the chain ends.

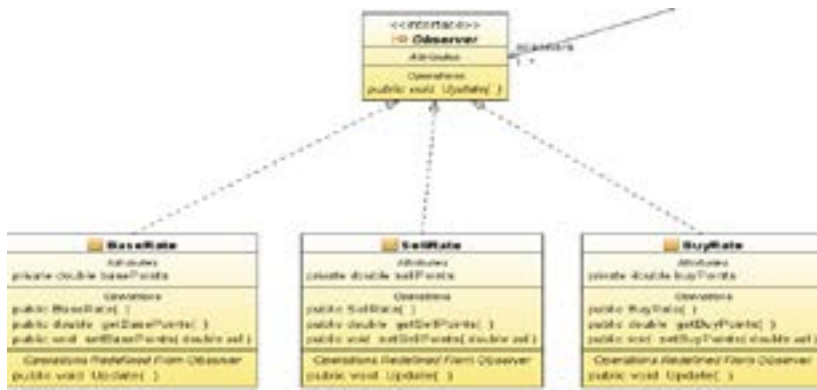
### 2.7 Observer as a pattern for exchange rate charts

Another functionality of the ATM Exchange system is the real-time display of the exchange rate. The exchange rate represents the trading percentages between different currencies for the value of each currency to be translated from one type of currency to another. As we know, the exchange rate changes constantly even within a day and often even within an hour. Given that we use different objects to display the exchange rate, which in our system are responsible for displaying the graphs with the exchange rate data, whenever there is a change in the exchange rate, this



change must be reflected in each of the objects. If this process were to be done manually, it would take a lot of time and would not be done immediately, and this would conflict with the functional requirements of the system, which include real-time information about the foreign exchange rate. Fortunately, there is a general solution known as The Observer design pattern for this problem. “Observer pattern defines a one-to-many dependency relationship between objects, such that when an object changes state, all its dependents are automatically notified and updated.” (Erich Gamma, 1994).

CLASS DIAGRAM OF THE OBSERVER PATTERN



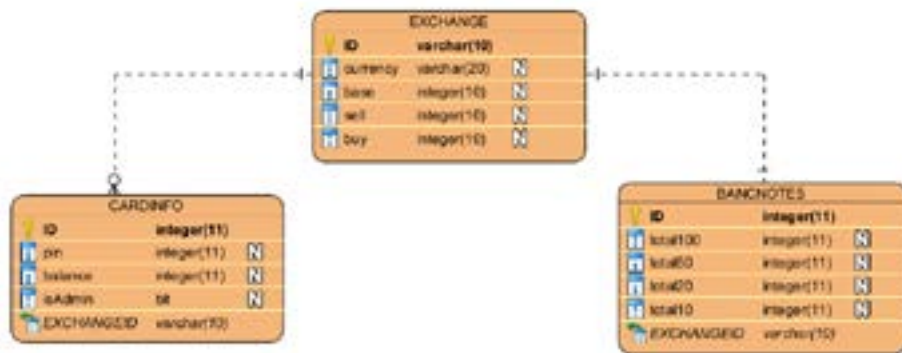
The figure above shows the Class diagram of the Observer pattern. This diagram contains an interface and three classes that implement the interface. The observer interface has a defined Update () method, which is declared in each of the classes that implement the interface, as the principle of polymorphism imposes. Each of these methods provides a different implementation of the same method for each of the exchange rate types, so we say that a polymorphic implementation of the Update () method is realized.

## 2.8 Entity relationship diagram

The database is the backbone of any information system. This is because the main function of a software is the storage and processing of data based on the requirements that users have. In the ATM Exchange prototype system, the database stores important information in terms of user data, exchange rate data and ATM status data. The entity relationship diagram of the ATM Exchange system has been built to visualize the database. This diagram consists of three entities which are “Cardinfo”, “Exchange” and “Bancnotes”. “Cardinfo” stores the attributes of card ID, primary key, pin, balance and “isAdmin or not” status. “Exchange” stores the data as the ID which is the primary key of the table, the currency type and the

three values of the exchange rate, the base rate, the selling rate and the buying rate. “Bancnotes” store the ID attribute values as the primary key, the total number of denomination of hundreds, fifties, twenties and tens.

ER DIAGRAM



As also shown in the ER diagram, “Exchange” with “Cardinfo” has a 1 x N relationship, because a currency can have many cards and a card belongs to only one currency type. On the other hand, the connection between “Exchange” and “Bancnotes” is a 1 x 1 connection since denominations in an ATM can only be in one currency and one currency has only one list of denominations. The ER diagram presented above only presents the basic functionalities of the system, since in this paper the goal is to explore the potential of providing solutions based on design patterns and not to design complex databases that store huge amounts of information.

## 2.9 Algorithm comments

After analyzing the functional requirements, defining the design patterns that would be needed to solve some of the key requirements of the system, and building the UML models of ATM Exchange, we are ready to develop the system. Since the developed system is a desktop application analogous to an ATM cash machine, the process of placing the card in the ATM is simulated by a login form.

The customer must have a personal account to access the system. The account is composed by the personal card number and the user’s password. If any of the credentials are incorrect, the user is shown an error message asking them to enter the correct details. In this way, an increased security of the system is enabled.

After successfully logging into the account, the user is presented with a menu from which he can choose between two options: check the account balance or perform a currency withdrawal.

The Java login code has logic such that if a user with the given credentials exists in the database, in the Cardinfo table, a check is made to read the value of the isAdmin column for that record. If the isAdmin value is false, the user will be redirected to the client panel. In the other case if the user has the value “isAdmin true”, it will be redirected to the administrator panel.

Selecting the balance check option enables the panel that presents information about the account status of the logged-in user. The information relates to the personal number of the card, the balance of the account and the corresponding currency.

The second option for withdrawing currencies, displays a panel where a simple form is presented in which the customer determines the amount he wants to withdraw from the ATM. On the other hand, three graphs show the exchange rate, named as: “The base rate”, “The purchase rate”, and “The sale rate” of different currencies.

The system is built based on some constraints, so that the model approximates the real model as much as possible. The amount that can be withdrawn from the ATM must be a multiple of ten. Also, the customer cannot withdraw an amount beyond the total that he has in his personal account. Another limitation is related to the total balance of the ATM. In case the customer requests to withdraw a larger amount compared to the ATM balance, there will be shown an informational message, just like in the two cases mentioned above.

Meanwhile, in case of success, the system prints a message showing to customer the banknote denominations of the completed transaction.

The second user entity is the administrator, who can also log into the system using personal credentials. His role is related to the management of the entire ATM system, where he can manage customer accounts, ATM card balances and exchange rates.

The administrator has the ability to manage the personal accounts of users, adding new customers, updating their data and deleting them from the system.

Since the fields are mandatory, if any of them is empty, an error message appears that all fields must be filled. Otherwise, it continues with the declaration of the query that inserts the data. Next, the method that makes the connection to the database is called. Communication with the database is carried out by means of a prepared statement, passing the values as parameters and not as values directly in the query. This is done for security reasons, since prepared statements are more protected against SQL injections and cyber-attacks.

In the ATM management option, the possible functions that he can perform are related to the maintenance of the state of the system in terms of its overall balance, through the addition, deletion and updating of banknotes that the customer can withdraw through his account.



Furthermore, exchange rate fluctuations, directly related to each client's personal accounts, are also managed by the admin. In this way, the interaction between the two actors is realized, enabling a simple system in use and maintenance.

## Conclusions

Based on the theoretical analysis and the development of the information system designed using design patterns, the following conclusions were reached:

- Software development based on design patterns provides fast, well-proven and reliable solutions to complex development problems. Using them properly allow us to create powerful software systems that meet end-user requirements and have a well-defined architecture.
- System modeling, which includes UML, use cases and sequence diagrams, in addition to enabling software visualization, improves the development process by accurately and quickly generating a significant amount of code directly from the model.
- When talking about a successful software application, it is not only about how it performs the function for which it was developed, but also about the efforts that have been made for its development, testing and maintenance. If this is not done correctly, the cost of development will result in an app that no one wants.
- Design principles enable writing better code. Also following these principles helps create a clean and modular design that is easier to test, debug and maintain in the future. Furthermore, features should be implemented when necessary and code duplication should be avoided. It should not be forgotten that a clean code is easier to understand and certainly saves time at the time of changes or new implementations.
- Object-oriented programming is a powerful and natural paradigm for creating programs that survive the inevitable changes that accompany the life cycle of any large software project.
- In the future, I would suggest raising the awareness of the developer community about the importance of studying and implementing design patterns as among the best development practices.
- Trends in banking and foreign exchange developments will continue to evolve as long as technology advances. Artificial intelligence will likely continue to advance data analysis and improve the way these market players interact with each other.

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# *Technical aspects of water supply and sewerage in Shkodër*

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***MSc. Ing. Dajana ARRTUNDA<sup>1</sup>***

ADVISOR: PROF. DR. TANIA FLOQI

## **Abstract**

*Water is a natural resource, with limited quantities and unevenly distributed in space and time. All forms of human life and activity are dependent on water.*

*As is known today, one of the main challenges in the region and the world is the preservation and development of water resources as a basic element for life to cover the basic requirements for drinking, then for agriculture and industry. Shkodra has a hydrographic system “Shkodra Lake - Drin River - Buna River”, which collects the waters of a basin with a total area of 19,582 km<sup>2</sup>. This considerable catchment area, with high and rugged mountainous relief and abundant intense rainfall, with special lithological construction of the terrain, in the presence of permeable limestone formations makes it possible for the hydrographic network of this basin to stand out for high and quiet diverse hydric potential. This network includes Shkodra Lake, Drin, Bune, Kir, and Gjadër rivers. The study aims to improve water supply and increase the effectiveness and sustainability of services to the citizens who are included in the intervention areas, the provision of clean drinking water and the creation of a sanitary clean environment through the administration of polluted waters, against acceptable fees which cover, at least, the operating expenses. The expected results are a good performance of the CUs, ensuring the proper service and operation of the CUs, efficient water supply, and sewerage systems. Knowledge of the technical aspects of the*

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<sup>1</sup> Dajana Arrtunda is a construction engineer. In 2020, she is graduated in “Geo-Environment” from the Faculty of Geology and Mining, at the Polytechnic University of Tirana. In 2022, she is graduated from the European University of Tirana with a Master of Science degree in “Construction Engineering”, profile “Transport Infrastructure”. During the years of studies, she worked as an engineer for the Italian company design SGAI Balcani and at the Geological Laboratory Geotest Shpk. Since February 2023, she is part of the K&K engineering company.

*CU Shkodër is necessary for citizens as it is directly related to the agent and the future of our children.*

**Key-words:** *water supply, disinfection, treatment, pumping station, natural resource.*

## **Introduction**

Shkodra extends for about 872.71 km<sup>2</sup> in the hydrographic node near the lake of the same name and the rivers Drin, Buna and Kir in a lowland “protected” by the lake, the Albanian Alps in the east where the peaks of Cukali (1,722m), Maranaj (1,576 m), Sheldia (Sardonic mountain of Barleti; from Shurdhah) and Tarabosh (about 700 m) to the west and the Adriatic Sea. The area in the middle of a plain, hilly, sub-mountainous, and mountainous relief, and the proximity to the Adriatic Sea and the lake of Shkodra have also defined its climate, a Mediterranean climate with mild and wet winters and hot and dry summers. Average annual temperatures range from 11.8 °C to 14.0 °C. The temperature in January is from 0.9 °C to 6 °C. In winter, the wind of Murrilan (local wind), is cold, strong and dry blows, while at the end of autumn, the wind blows, which is accompanied by precipitation and swelling of rivers. The amount of precipitation in this city is large. On average, 2500 mm of rain falls there per year, so it is one of the wettest areas of Albania. The coldest month of the year is January, while the hottest month of the year is July. Snow falls rarely, while frosts usually occur at the end of the year. The “Shkodra Lake - Drin River - Buna River” hydrographic system collects the waters of a basin with a total area of 19,582 km<sup>2</sup>. This considerable water catchment area, with high relief and broken mountain and with abundant intense rainfall, with a special lithological construction of the terrain, in the presence of permeable limestone formations makes it possible for the hydrographic network of this basin to stand out for high and quite diverse hydric potential. This network includes Shkodra Lake, Drin, Buna, Kir and Gjadër rivers. The Buna river delta with its characteristic alluvial islands is special in this respect. First, in terms of biodiversity and natural productivity, the water network, especially the hydrographic one of Shkodra, has special and almost unique values. From a scientific point of view and knowledge of the lake, information on its biodiversity is rich. The biological diversity of Lake Shkodra has increased under exceptional geomorphological, geographical, climatic and ecological conditions. Biological diversity is high and the whole area is considered a biogenetic reserve of European importance. Lake Shkodra is located in the northwestern part of Albania and on the border with Montenegro. It has an average height of 5 m above sea level and is the largest lake in the Balkan Peninsula,



with an area of 368 km<sup>2</sup> of which 149 km<sup>2</sup> lies in Albanian territory and the rest in Montenegro. The average depth is 10 m, the average water temperature is 16.5 °C and the Mediterranean climate prevails. Irrigation canals, aqueducts, dams, bridges - since ancient times, man has created all kinds of structures - in the water, on the water, near water and even under water. Water pipes deserve special attention. These are canals, pipes and water channels necessary to provide the city with water, even if the settlement is higher than itself. A water supply is an integral system and must be considered comprehensively along its entire length from the source to the final point of consumption. According to the United Nations Organization (UN-WATER publication)<sup>2</sup> [27] Globally, agriculture (including irrigation, livestock and aquaculture) is by far the largest consumer of water, accounting for 69% of water use at the level globally, industry (including energy production) accounts for 19%, while households only 12%.

## **Water supply, sewerage, drinking water supply**

Irrigation canals, aqueducts, dams, bridges - since ancient times, man has created all kinds of Structures - in water, on water, near water and even under water. Water pipes deserve special attention. These are canals, pipes and water channels necessary to provide the city with water, even if the settlement is higher than itself. A water pipeline is an integral system and must be considered comprehensively along the entire length from the source to the final point of consumption. The water pipelines could be laid both underground and on its surface. In the latter case, the aqueducts were superimposed from above, so that the water did not carry dirt and garbage into the city. Where aqueducts ran through pits and vaulted spaces were built - true architectural marvels. These arches had many levels, which not only looked beautiful but also ensured the stability of the entire structure. The construction of aqueducts began at the beginning of the 20th century. The first information that has come down to our time is about the aqueduct, erected in 603 BC. The structure supplied water to Assyria's capital, Nineveh. In the ancient and also built aqueducts. But the longest was built in Antiquity, its length is more than 315 kilometers. Ancient Roman aqueducts, however, cannot be compared: they differ not only in the grandeur of their construction but also in scale. Some ancient buildings have survived to this day. The need for clean drinking water led the ancient Romans to build aqueducts as early as the 4th century BC. The first aqueduct built - Aquia Apia - was 16 kilometers long. In ancient times, almost a third of the entire empire was supplied with clean water.

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<sup>2</sup> Sustainable Development Goal 6 Synthesis Report on Water and Sanitation, 2018



In the city of Shkodra, two wastewater treatment plants are operational, one in Shiroka and one in Velipojë. ITUN of Shiroka has been operating since 2013. It occupies a land area of 1,913 m<sup>2</sup> with sufficient capacity for an equivalent population of 2 thousand inhabitants. Under the conditions of operation at full capacity, the plant consumes about 22 thousand (kwh) of electricity. ITUN of Velipoja has been operating since 2016. It occupies a land area of 2 hectares with sufficient capacity for an equivalent population of 54 thousand inhabitants. Under the conditions of operation at full capacity, the plant consumes about 22 thousand (kWh) of electricity. In ITUN they do not discharge industrial waters and the secondary level of dirty water treatment is used. There is 1 pumping station that transports/discharges the waters of the main collectors in ITUN and the host water body is Lake Shkodra. The lifespan of ITUN Shiroke according to the project is 15 years.

## **Drinking Water Production**

Sh.a.UK Shkodër uses underground water sources through which it produces an average of 12.6 million m<sup>3</sup> of water per year, through 21 systems with mechanical lifting and 2 systems with free flow. The entire volume of produced water is estimated at (100%). Sh.a. UK Shkodër implements a regular work program for the detection of water losses and has a formalized system for registering consumer complaints. The study mainly deals with the water supply system connected to the area of the Dobrac wells. From the above, it will be seen that about 80,300 people living in Shkodër and its suburbs are supplied by this main source of water, including the two villages of Dobrac and Golem. The Dobrac well area generally provides sufficient water of good quality, but the water needs to be protected from pollution from residents living near the well field.

The large number of consumers with “0” consumption can be due to two reasons:

- a) The emigrant population abroad - these houses are closed and in many cases are only used for a few weeks during the summer holidays.
- b) Houses with illegal connections and/or bypassing of the water meter, which is expected in many cases in Dobrac and Golem. At the moment, the village of Golem has 0 (zero) registered consumers, but it is known that many houses are connected to the old pipes, which are related to the field of Dobrac wells.

Ten wells equipped with submersible pumps raise the water to an intermediate tank nearby, from where it is pumped directly into the supply system and also to



the reservoirs located on Tepe Hill. From there, distribution is by gravity. While the entire network of Shkodra (approximately 263 km) is interconnected, at the moment no well-organized supply concept it is possible.

## **Dobrac Wells Field**

The city of Shkodra is supplied by an underground water source, called “Field of Dobraci Wells”, which is located in the north of the city, between the Kir River in the east and Lake Shkodra in the west. Characteristics of the Wells field with its eleven (11) wells. Three (3) wells were equipped in 2000 with submersible pumps funded by the ADA, along with pressure and flow meters. The pumps were inspected and found to have corrosion, both in the pump itself and in the pipe going up, moreover, the current condition of the mechanical works and civil structure is very bad. Close inspection of pumps and pipes Current situation inside the wellbore. Recently, three (3) of the well pumps were replaced with KSB pumps and are assumed to still be performing well. Well, No. 9 is currently out of service due to the lack of a pump while the well is reported to be filled with stones. Although the pumps are monitored by the recently installed “SCADA system”, none of them are connected to the Intermediate Reservoirs using the smart remote control system, so the pumps are switched on and off manually by the Operator when signaled with the mobile phone.

## **Main Pumping Station**

Untreated water is pumped from the wells to the Intermediate Reservoir by pumping pipes DN250 to DN400, with lengths from 150 m to 1 km. The connecting pipes between the wells, as well as those of the reservoirs, are made of steel, and pass under private and agricultural plots.

### *Intermediate Reservoirs*

Wells No. 8, 9, 10 & 11 pump water through two (2) separate lines to the 40-year-old “Old Intermediate Reservoir”, with a volume of 150 m<sup>3</sup>, (single tank), while wells No. 1, 2, 4, 5, 6 & 7 are connected first to the recently reconstructed well, and then to the “New Intermediate Reservoir” with a capacity of 1000 m<sup>3</sup>, (double tank), also newly built, with Contract Works No. 3.

However, in the last project financed by KfW-SECO-ADA, it was envisaged to reconnect all the wells to the new Intermediate Reservoir, but this turned out to be

impossible due to a lack of funds. The general condition of the “Old Intermediate Reservoir” (civil structure and mechanical equipment) can be described as bad. The “New Intermediate Reservoir” was built recently, but it is noted that neither the water overflow nor the water level measurement valves have been installed, while the butterfly valves for starting the engine are opened and closed manually.

### *Disinfection*

In the “New Intermediate Reservoir,” the automatic chlorination plant (liquid hypochlorite) and the Chlorine Analyzer have been installed and are functioning. However, since the EFMs at the New Pumping Station are out of order, Chlorine dosing is at the discretion of the operator.

### *Pumping Stations*

From the Intermediate Reservoirs, water is pumped into the network from two pumping stations, located in the Dobrac Well Field. The old pumping station has been built for about 50 years but continues to operate, while only one (1) pump out of four (4) is currently in operation.

The New Pumping Station (funded by ADA and built-in 1999), consists of three (3) pumps, all operational. In principle, there are two main lines for the supply of Shkodra from the “New Pumping Station. The so-called New Main Pipe, (NTM) acts as the main transmission, which sends water from the New Pumping Station to the so-called Hill Reservoirs, (R4, R3, and R2) and consists of a pipeline installed with a length of 5 km DN400 ductile iron, implemented by ADA in 2000. A part of this line lies under agricultural and private areas from the Old Pumping Station. The Old Main Pipe (OTM), a DN 400mm steel pipe, was previously used as the main transmission to supply tanks R1, R, 2 and R3

### *Distribution Wells*

To supply the city with water, there are two wells (rooms) that are connected to the “Old Pumping Station”,

## **Dobrac well**

- a) Manhole in Dobrac The well of Dobrac is located in the north of the city and is currently surrounded by houses built without permission. The access to the newly built well, with the financing of the KfW-SECO-ADA project, is

- closed with a high concrete wall, to prevent the entry of residents and illegal interventions in the system. The following areas are supplied from the well;
- b) Industrial Wells (IND) served as distribution wells for the former timber processing industry, in the industrial area, in the northeast of Shkodra. Today a steel pipe, DN300, extends to the southeast to supply the city.
- 2.7.2.3.3 Reservoirs Currently there are four (4) reservoirs of which only three (3) have water while one is out of order. All reservoirs are located on Kodër Tepe, south of the city, with a total capacity of 13,800 m<sup>3</sup>. The entire holding capacity is/would be sufficient to meet all current water demands, also accounting for the 30% reserve capacity required to meet peak demand cases.

## **Contaminated Water, Sewerage Network**

The existing Wastewater network was designed to function as a separate system, but due to faulty connections, it now functions as a combined system. Discharge to the Main Sewage Pumping Station located in the south of the city, near the Buna, is done by gravity and mainly through three (3) Main Collectors. These three collectors are connected and discharged by gravity through a DN 1200 transmission (K0 with a length of 1.1 km) to the mentioned MSPs. All the polluted water collected inside the urban area is pumped from the Main Sewage Pumping Station to the Drin River without any treatment. This is done to eliminate spillage in Lake Shkodra to protect it from pollution. MPS (Station) Shkodra has recently been rehabilitated, within the framework of the KfW-SECO-ADA project. The rehabilitation works aimed to completely replace the E&M equipment, replace the DN500 discharge pipeline, build a new sand trap, as well as build a new emergency discharger, in addition to renovating the structure itself. MPS is equipped with five submersible pumps, (Q = 540 m<sup>3</sup>/h, h= 15 m) with a total capacity of 2,700 m<sup>3</sup>/h. The main priorities for the wastewater system in Shkodër expressed by the client for the current project are the implementation of a WWTP and all measures required to start operation as soon as possible.

Expanding and rehabilitating the wastewater collection network is ranked lower than the WWTP in the ranking of priorities. None of the connected dwellings use septic tanks or septic tanks for water discharge, so the liquid matter coming from the waste is infiltrated into the ground. When needed, the tanks are emptied by suction trucks brought by private individuals. The current wastewater network was designed to function as a separate system, but due to faulty connections, it now functions as a combined system. The current state of the polluted water network is as follows;

The grating cleaning elements must be of the adaptable type to ensure a high discharge capacity. Due to the installation depth and limited space, the grate must be of the vertical type with the incorporation of a dewatering and compaction mechanism. The waste is automatically discharged into a container, which is placed at ground level, while the grate installation should be approx. 4 mbgl

The main uncovered areas are the informal areas in the east, north and west of the city (respectively the village of Dobraci [the part that belongs to the urban area of Shkodra and is not connected], Ish-Zotekniku, Livade and Mark Lula). Currently, unconnected/uncovered households mainly use pits or septic tanks to remove Dirty water. As a result, polluted water from those pits infiltrates into the ground. When necessary, these tanks are emptied by suction trucks organized at a private level, which is outside the control of the UKS. Therefore, it is of great importance to connect these areas with the collector system of Shkodra.

## **Wastewater Treatment Plant**

Wastewater that is generated by all human activities must be treated in a wastewater treatment plant. ITUNs are wastewater treatment plants and serve to achieve the highest degree of purification of these waters. This is the water that results from human activities that come from cities, industry, agriculture, etc. Being a potential risk for the host environment and human health since spills and leaks of toxic substances that contain them also in special cases cause ecological damage.

To return to the natural environment of the host without causing ecological damage to it, the main goal is to reduce the pollutants, to reduce them within the permitted limits. Treatments vary depending on the characteristics of the wastewater and its final destination. We know that urban wastewater is collected through a circuit of drains and collectors that make it reach wastewater treatment plants. Water in the plant is subjected to different treatments to achieve the level of purification needed for different purposes or according to the respective destination.

Through these plants they undergo the following treatments:

- I. Pre-treatment: It consists of the removal of solids of different dimensions, and the removal of fats, and oils. This process is necessary to remove most of the pollutants that would hinder subsequent treatments.
- II. The primary treatment removes a large amount of pollution, after the primary treatment 30% has been removed
- III. Secondary treatment. It is the further treatment of water and as a treatment, it has a high cost.



## *Primary Treatment*

It consists of several physicochemical processes that are applied to reduce the content of suspended particles in water. Most of the suspended solids found may be sedimentable or floating. Those that are sedimentable usually reach the bottom after a short period, while the latter are particles so small that they are already integrated into the water and cannot float my sediment. To eliminate these smaller particles, other more demanding treatments are needed.

Some methods used in primary treatment include the following:

- **Sedimentation:** is the process by which sedimentary particles can fall to the bottom thanks to the action of gravity. In this process, which is simple and inexpensive, up to 40% of the solids contained in the water can be eliminated. Inside the treatment plant, there are tanks called decanters and this is where sedimentation takes place.
- **Float:** It consists of the removal of foams, fats and oils since, due to their low density, they tend to settle in the surface layer of water. In this process, it is also possible to remove lower-density particles. For this, it is necessary to inject air bubbles to facilitate their adhesion and elimination. With this float, up to 75% of suspended solids can be removed. This process takes place in other tanks called dissolved air floats.
- **Neutralization:** it is a process that consists in normalizing the pH. This means that the water should be adjusted to a pH between 6-8.5.

Other processes: if you want to achieve greater purification of polluted water, some techniques are applied such as the use of septic tanks, lagoons, green filters, or other chemical processes such as ion exchange, reducing the biological need for oxygen, etc.

## *Secondary treatment*

As we have mentioned before, unless a high degree of purification is required, this secondary treatment is not carried out in urban wastewater plants. It consists of a series of biological processes that aim to almost eliminate the organic matter present. They are biological processes in which certain bacteria and microorganisms are used to convert organic matter into cellular biomass, energy, gases and water. The advantage of this treatment over others is that it achieves a high degree of pastrami up to 90%.

In the secondary treatment of urban wastewater treatment plants, there are two types of aerobic and anaerobic processes. The first is in the presence of oxygen and the second is in the absence of oxygen.

- **Aerobic processes:** these processes take place in the presence of oxygen, which is blown in different ways and passes into the aeration tanks, where the polluted water enters. During this phase, organic matter degrades and water and carbon dioxide are released, the rest of the organic matter serves as food for the microorganisms that multiply and serve as food for them. In addition to these microorganisms, we have protozoa, algae and other species up to intervertebral “worms”. Nitrogen products such as ammonia, which is a highly toxic nitrogen derivative, are eliminated in this phase. Although nitrate is no longer toxic, it is a form that can be taken up by plants, so it can cause algae to grow and regenerate their nutrients. After secondary treatment, the waters containing nitrogen and phosphorus compounds being discharged into the host environment cause eutrophication, i.e. the increase of macrophytes.
- **Anaerobic processes:** These processes take place in the absence of oxygen and the fermentation process takes place in which the organic matter is transformed into carbon dioxide and methane gas 60-70%

The plant in Shkodër has a biological filter, where the water is thrown from above the tank in the form of a shower and during the shower, it is enriched with oxygen from the air.

The biological filter is a concrete tank filled with plastic materials that have empty spaces between them exactly, in the waters of these plastics, a biological layer is created through which oxygen-enriched waters pass and the pollutants of these waters serve as food for the biological layers, the biological active sludge is in continuous movement with the waters, while here the biological layer is motionless, then through the drainage they pass to the secondary decanter where the water is separated from the biological layer “sludge”. Water comes from above the biological layer comes from below.

### *Tertiary Treatment*

For the second phase of implementation, biological phosphorus removal will be done by adding Disc Filters (Microscreening-Microgrid).

The P- elimination will require the following additional units:

- Anaerobic Bio-Phosphorus Tank (phase 2)
- Chemical dosing station;



Tertiary treatment will respond to the improvement needs for waste discharge standards, especially concerning the expected classification of the received water as a sensitive water body with stricter phosphorus requirements.

### *Alternatives Proposed for Biological Treatment during Project Concept*

ITUN Alternative 1: Traditional activated sludge process.

Sludge processing tanks in the first phase of implementation will be dimensioned for the removal of organic pollution with BOD / COD with a sludge treatment time of only four to five days.

*The sludge processing plant will consist of the following units:*

- Deposits (cisterns - to be expanded in phase 2)
- Ventilation Station
- Secondary Sedimentation/Cleaning Deposits;
- Return of activated sludge (RAS) and excess sludge pumping station.

Detailed process calculation and item description of the Activated Sludge Plant for alternative 1 are provided in Appendix 3.2 and related drawings of the Final Project Concept Report.

WWTP Alternative 2: SBR-Technology

*The SBR plant will consist of the following units:*

- Intermediate pumping station;
- SBR deposits (to be upgraded in phase 2);
- Ventilation Station (Diffuser).

A detailed process calculation and item description of the SBR Plant for Alternative 2 is provided in Appendix 3.3 and related drawings of the Final Project Concept Report

The following interventions are not necessary in the case of SBR technology:

- Final sedimentation deposits;
- Sludge return cycle.

This means that the main differences compared to the traditional system (Activated sludge) are related to the volume of the biological reactor, the aeration capacity and the measurement/regulation of this phase. Furthermore, the sludge load and its treatment are reduced to some extent. The capacities of subsequent purification measures such as filtration and UV irradiation have increased to some extent due to the permanent operation of biological reactors.



## *Selected Option*

As mentioned above, the biological treatment of polluted water should be based on the One-Phase Activated Sludge Plant. To avoid zooming a measured implementation was suggested. In the first phase, a One-Stage Activated Sludge plant with simultaneous aerobic sludge stabilization is envisaged to treat wastewater with at least 36,000 PE. The activated sludge tanks in phase 1 are already dimensioned to cover 100% of the necessary biological treatment capacity of phase 2 with special stabilization of anaerobic sludge. For phosphorus elimination, a chemical dosing station will be implemented in phase 1.

In stage 2, an anaerobic Bio-Phosphorus deposit is added to reduce chemical demand. The secondary concentration tanks in stage 1 are designed to cover at least 50% of the hydraulic capacity of stage 2.

## *Sludge treatment*

To achieve  $DS \geq 35\%$ , it is envisaged that the sludge treatment process will consist of the following units:

- Excess sludge gravity thickener;
- Simultaneous aerobic stabilization of sludge in activated sludge deposits (phase 1)
- Anaerobic digester and CHP for Anaerobic stabilization of sludge (phase 2);
- Sludge storage tanks;
- Centrifuges for drying sludge;
- Lime deposit in cylinders for liming treatment (Optional)
- Sludge solidification area (compost).
- Filtration storage tank.
- (Optional facility for solar sludge drying)

## **Risks of the Study**

### *Population Development*

The rate of population growth is always an assumption that depends on the economic development of a region, local, regional and international factors, political influence and also climate changes, and therefore are not 100% predictable.

Available official figures show a slightly negative growth rate in the Shkodra district, but this may vary for some specific suburbs of the city of Shkodra or the city center. As a compromise, it has been agreed to calculate a growth rate of “0” until the duration of the project 2045 for the project area and to use the current figures of the Municipality of Shkodër as a baseline.

### *The ambiguity of population data*

It is a fact that many people are emigrating from Albania to other countries but continue to remain registered in their towns and villages. They usually come back for some are home during the holidays, but during the rest of the year, no one lives in their houses or apartments. This may be one of the reasons for the high number of connections with “0” water consumption. For the calculation of pipes and main components of the water supply and sewage system, the total number of connections was used. But for the Plant, it was agreed to apply a much lower number of connections to avoid enlarging the plant. The base for phase 1 was set at 36,000 PE and for phase 2 an increase of 69,000 PE (in total 105,000 PE). The basis for phase 2 can be adjusted according to new data, which will be collected during the operation of the complete system and which will be even more accurate and a better basis for further considerations.

### *Uncertainty about the Water Balance*

As a general approach, it is assumed that by the end of the implementation phase consumption per capita will increase from  $102 \text{ l / c * d}$  to  $120 \text{ l / c * d}$  and will remain stable until the duration of the project 2045. Also, the figure actual is a calculated value and varies between  $76 \text{ L/C*d}$  for household connections with water meters and  $140 \text{ L/C*d}$  for connections that pay the water fee according to the flat rate. Inactive connections are included in this calculation. Applying only the active connections, the specific water consumption could have been calculated with  $102 \text{ L/C*d}$  (connection with water meter), with  $186 \text{ L/C*d}$  for connections with afrofe and an average of  $135 \text{ L/C*d}$ . The reality may be somewhere in between, and the applied and internationally accepted value of  $120 \text{ L/C*d}$  seems realistic for future considerations. By having all connections equipped with water meters, as is an objective of this project, it may happen that the average consumption per capita normally decreases instead of increasing.

The division of losses into apparent losses and real losses according to the IWA is based on several assumptions, because only a few measured values are available. With the proposed measures mainly replacing the old network, connecting unserved households (which are actually illegally connected) and completely

disconnecting the old network, it is expected that the apparent losses will be significantly reduced.

This will depend on the strength of the Water Company, how strictly they will staff and maintain the system with full billing based on water meters, identification of illegal connections, proper DMA-based water balance calculations, management of pressure, active leak detection and immediate response to reported problems.

### *Coordination with other projects*

It is a well-known risk that poor coordination with other ongoing or anticipated projects can lead to duplication of investments, and non-adjustment of concepts developed by different parties. The reality shows that collecting the possible information about the envisaged projects is quite difficult and there is also no guarantee that the project ideas will be implemented.

In the case of Shkodra, it is important to have the certainty of the government project, which aims to rehabilitate the main pumping station and one of the feeder lines, before the implementation starts and the same concept is followed.

### *Financial Insecurity*

Project funding is pre-agreed and guaranteed by KfW on behalf of all other donors. But the submission of offers may exceed the fixed funds. In this case, it will be necessary to remove some small works, but with additional funds applied as the contingency of 10% and other expenses of 5%, it is not very likely that such a situation will occur.

## **Recommendation**

As some feeder lines pass through private land and residential areas without a distribution network, there are many illegal connections and because of this fact, UK Shkodër is facing huge losses. The main priorities for the Shkodër water supply system expressed by the client for the current project are:

- Structuring the entire water supply system in the DMA with sizes between 3,000 and 5,000 connections per area
- Reducing water losses through the elimination of illegal connections and the replacement of supply lines that cross private land
- Rehabilitation of old networks within highly populated sectors of the city center (which have a low specific cost per person)

- Strengthening UK Shkodër to improve operations for the entire supply system and to run all sectors energetically and cost-effectively.

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# *ERP Systems in business function* \_\_\_\_\_

Management of fixed assets and contracts modules in Microsoft Dynamics 365 Business Central

\_\_\_\_\_ *MSc. Emanuela MARAJ*<sup>1</sup> \_\_\_\_\_

## **Abstract**

*ERP software can integrate all the processes needed to run a company and companies use ERP systems - (Enterprise Resource Planning) for various reasons, such as the expansion and improvement of business operations as well as the reduction of costs during the activity.*

*Automating business processes eliminates waste, improves work accuracy and improves productivity. Departments with processes from the simplest to the most complex can now synchronize work and communication to achieve faster and more successful results. Following each of the reasons, medium and large companies now operate in business with the help of ERP systems, technology and various information systems. Nevertheless, the goal of the process for a successful implementation project is to customize the ERP system according to the business needs and client's requirements.*

*During the implementation of an ERP information system, there is a need to adapt the system to the client's requirements and the activity performed, so it is important that the system can leave room for changes and adaptation, but without going out of its way of operation and construction.*

*In this scientific paper, we will deal with the implementation of two separate modules in the Microsoft Dynamics 365 Business Central 2020 - Wave 2 standard system, to achieve the adaptation of the client's requirements to the system.*

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*The first implemented module will be the Contracts Module, which will be developed in new facilities with a new logic adapting to the system and workflow, since the system does not offer contract management by itself. This module aims to fully implement the management of contracts, framework agreements and amendments.*

*The second implemented module will be the Fixed Assets Module, which will adapt to a new logic and what the system offers. This implementation will combine development in the Base Application objects and new Custom objects and will handle the transfer of fixed assets between companies that are subsidiaries of a parent company, which is not possible in the system by maintaining the history of these movements.*

*Following this paper, the methodology, implementation and development carried out during the implementation of this project are explained.*

**Keywords:** ERP, Microsoft Dynamics 365 Business Central, Enterprise Resource Planning, Implementation, Base Application, Modules, Customization.

## **Introduction**

The realization of this scientific paper was carried out by describing the implementation of the ERP system - Microsoft Dynamics Business Central in a company whose main field of activity is the management of motor capital, fixed assets and their subcontracting.

The main object in the implementation of two modules (Fixed Assets Module and Contracts Module) has been to achieve the most efficient management according to the client's requirements in accordance with the implemented basic system of fixed assets and contracts. The objectives of the implementation of both modules are to offer to the client what the system does not enable on its own basis.

The objective of the Fixed Assets Module is to realize the transfer of physical capitals and fixed assets between two companies while also preserving their history. Currently, the system only allowed internal movement between two warehouses, within the same company.

The objective of the Contracts Module is the complete realization of a part of the system to realize the management of contracts, framework agreements and amendments. Currently, the management of these data was not possible in the system.

The successful realization of the client's requirements by achieving their implementation in the system by building the connection with the existing flow of information in the system is the main goal of the realization and implementation of this work and project. Once both modules have been implemented and the

client's requirements have been met, it is expected that the transfer of physical assets between the two companies, as well as the management of their contracts and data, can be carried out successfully.

This paper is organized as follows: in Section II is shown related material and methods; Section III presents hypotheses and research questions for the study; the literature review is presented in Section IV; in Section V is shown the analyses of modules; in Section VI is presented the solution implementation of each module and the Section VII draws implementation results and conclusions.

## Material and Methods

The methodology used in this scientific paper is the *Agile methodology*, which encourages the management of a project to move quickly by dividing the defined time into several phases. Continuous cooperation with the client brings continuous improvement in each phase, starting from the initiation process such as the planning and evaluation of each step, until the completion of the delivery of the project to the client.

In the implementation of Microsoft Dynamics products, the Agile methodology applied is *Microsoft Dynamics Sure Step*, which is structured with step-by-step descriptions and activities to complete each stage of an implementation. This applied methodology brings to the project a faster implementation time by making available tools and best work practices to increase the sustainability, quality and success of the project [Shankar & Bellefroid, 2011).

It is a very flexible model and can be adapted to any business or industry project by constantly following the working procedures of the Dynamics product. The method provides a standard set of stages that guide the project implementers towards the fastest and most complete realization of the project with a minimal risk of loss, which brings an increase in customer satisfaction for the result.

The first stage is the determination of the solution that will fulfill the client's needs and after this solution is agreed through the analysis, which is the second stage, the steps are defined to plan the project in the most efficient way.

During the design phase, the client's requirements determined during the analysis are met which can be fulfilled by the Microsoft Dynamics Business Central core package itself.

If during the Analysis phase it is understood that there are requirements that the basic package cannot support, then we enter the Development phase, in which system elements will be built within the project specifications, such as the built of new interfaces and processes the system. After the end of the development phase, the project is implemented and all the work done is concluded in a final product



of Microsoft Dynamics, which is presented to the client to prepare with the newly implemented new work environment (Community Dynamics. *Setup Table*, 2016).

At the end of the project, support is offered in training, continuous support to help the client to transition as easily as possible to the new system, thus disconnecting from the old work system.

During the realization of this scientific paper, the platforms as the basic package of Microsoft Dynamics Business Central and Visual Studio Code as a development environment, are used.

## Hypotheses and research questions

*Hypothesis:* Implementation in an ERP system of two modules that manage the data of the transfer of physical assets and contracts offers the company more security, history during the storage of information and efficiency during other business processes such as the processing, transfer and distribution of data.

This study will attempt to address the following research question:

(1) Does the implementation of an information system - ERP, positively change the work process of a company whose work process is the transfer of physical goods and their subcontracting?

## Literature Review

### A. *The importance of ERP Systems in business*

At its core, an ERP is a software system designed to integrate and automate an organization's processes into a single common system.

These systems usually have a common database which helps ensure that information used across the enterprise is centralized.

As companies expand, their needs change and their systems cannot meet all needs or perform all processes that can help the business run smoothly. The solution would be to use a centralized system that can automate all business processes and needs such as: Sales, Purchase, Production, Human Resources, Fixed Assets, etc.

Through a single database, ERP systems collect, store and analyze data across all departments. Storing and analyzing data across departments ensures smooth communication within the business (Alphavima, 2022).

Today's ERP systems have features and functions that bring countless benefits to businesses, starting with the main advantage that is Standardization of business processes.



By consolidating data into a single database, information is easily compiled and can be reported in real time and accurately. Improved reporting helps the business understand how a change or process affects the rest of the company.

One of the most important advantages of enterprise resource planning software today is its modular and flexible composition.

Most ERP system providers offer several applications that can work together according to business needs where each application stands alone or integrates with other applications or services. In this way, the company can select the modules and system services it needs and leave out the ones it doesn't.

Risk management and data security are achieved as a result of well-defined workflows which strengthen financial controls and reduce fraud or errors that can lead to losses. To protect this sensitive business data, ERP uses special security protocols.

The greatest facility that ERP systems allow is the customization that can be achieved according to customer requirements by working on the basic objects of the system.

Customization can also turn into a weak point for implementing ERP systems as customizing the system can require a lot of time, effort and investment.

By underestimating the resources needed, businesses don't complete their customizations or go over budget.

Further on the disadvantages of ERP systems we can mention the Price as only the initial cost of the system can be high and unaffordable, especially for small and medium businesses.

## *B. Contract management in business and other information systems*

Contract management is the phase of the subcontracting life cycle where a contract is entered into in an agreement, and the contractor and buyer work together to fulfill the contract requirements. Contract management may include qualitative and quantitative measures, performance measures, communication, reporting and monitoring activities.

Before the introduction of the Contracts Module, or the electronic transmission of data to support the contracting function, a company's contracting system was usually handled by paper. This process was inefficient and a tedious process for professionals.

Some of the benefits that this module brings are:

**Functionality:** Proper management of the contracting process from start to finish by managing requirements and automatically analyzing those requirements related to the system.

**Flexibility:** Thanks to the contract module, the system will be more customized.

**Mobility:** The system enables access to data from almost any device at any time.

**Increased productivity:** Performing procedures in the Contracts module takes less time than traditional procedures.

**Archiving:** With contracting module all contract data is stored on servers, significantly reducing the exposure of sensitive data or physical loss without their return.

**Transparency:** Contract transaction tracking can provide a complete overview of reporting on claims, orders processed and payments made. The Contracts module ensures compliance with current and established contracts.

During the life cycle of a contract, one or both parties who have concluded the agreement may feel the need to change one or several points of the contract. This means that there may be changes in the basic rights or obligations of a contract and thus the contract is amended. This contract change, which will now be called an Amendment, can be created as a result:

- Changing the term of the contract.
- Changing the price of a contract.
- Changing product quantities.

Most standard forms of contract include a right on the part of the contractor for interim payment until full payment is made. These payments help the contractor's cash flow and are amounts paid that the contractor may be entitled to recover from the other party. Interim payments can be agreed in advance and paid at specific times, but they are mostly regular payments, the value of which is based on the value of the work that has been completed.

Poor contract management can cause conflict between work teams which leads to a slowdown in work speed that harms the company's ability to finalize a deal. This poor management can result in the loss of key data which leads to very high costs for the company.

A main purpose of building the contract management module is to create a registration system to reduce this risk.

The Contract Management module is not part of the basic package of Microsoft Dynamics Business Central; Therefore, to adapt to the client's requirements, based on the way contracts are managed in business, we will implement from the beginning this module, which is not currently enabled in the system.

Following the work, this module will be analyzed, developed and then implemented in the Contracts module in Microsoft Dynamics Business Central according to our customizations.

In recent years, businesses have paid more attention to the management of business contracts because for a business it is an important point of its activity.

Contracts and their constituent terms have a long preparation time coupled with a manual work done which businesses aim to reduce.

In order to reduce this manual work, many companies, including in our country and in the region, have chosen to perform this work process through information systems such as ERPs.

In the case we are dealing with, the system we are working with, Microsoft Dynamics Business Central, does not offer the Contracts Module in its basic application, but through the customization feature that this system allows us, this module is being created.

Creating a module from the beginning according to the client's requirements, in this case the business enables the customization according to the specific needs to be unique and to be able to adapt to all the expectations that the business has in terms of contract management in Microsoft Dynamics Business Central.

But many ERP systems themselves have it implemented in the basic application where we can mention Oracle - JD Edwards EnterpriseOne, SAP Business One, Aura Quantic as well as Dynamics AX implemented in business management of various industries (B3technologies, 2020).

In these systems, the contract module is developed in a standard way for all types of industries in order to adapt to all business requirements as a whole.

In general, as in our country or in the region, the implementation of ERP systems encounters difficulties for several reasons, such as the difficulty of adapting users, the small number of large businesses, the very high price of the initial implementation.

### *C. Management of Fixed Assets in business and other information systems*

Fixed Asset Management contains all the options and functionalities needed to manage fixed assets, tracking their location and maintenance for assets such as vehicles, computers, machinery, etc.

A fixed asset can be described as an asset, not specifically a physical asset, which is purchased for long-term use and cannot be quickly turned into cash, making the comparison with a current asset, which includes financial instruments that can be quickly turned into cash within a year. The management of fixed assets can be managed through an information system by:

- Monitor fixed assets.
- Supervised equipment and machinery in multiple locations.
- Supervise the maintenance costs of fixed assets.

- Improved operational efficiency.
- Record assets that are decommissioned, sold, stolen or lost.

By managing this data, the number of lost inventories is reduced and the lifetime value of a fixed asset is increased, which leads the company towards increased prospects to ensure the best return on investment.

Otherwise the company may experience equipment failures, an incorrect inventory and safety or environmental violations.

Over time, many fixed assets depreciate and become less valuable, such as work equipment in an activity or software that may become less valuable with new versions released to the market.

Tracking the total value of fixed assets, their depreciation and placement is very important.

It is necessary for companies to properly manage fixed assets using a software that will help in planning, managing their maintenance.

The information systems implemented in the company integrate fixed asset data throughout the asset's life cycle starting from purchase, various financial actions, maintenance, depreciation, renovation and location.

By performing a series of tasks such as tracking the location of fixed assets, automatic depreciation calculations and tracking requests for repairs and maintenance, the information system will be an added value for the company, facilitating management for employees as well.

Microsoft Dynamics Business Central provides a complete functionality in the management of fixed assets for a company by means of an overview of fixed assets ensuring their correct periodic depreciation; It enables the tracking of maintenance costs, asset location, management of fixed asset transactions as well as the generation of various reports and statistics.

In our basic package of Microsoft Dynamics Business Central the location of the asset is managed in a virtual warehouse and is connected to the table FA Location (it is a separate table in which we can add the Code (FA Location Code) and Description (Description) for the location of the asset, so this table is not connected to the Location table that is used for placing physical assets - Items in the system). The system enables based on FA Location only the internal movement of fixed assets within the same company.

In any company regardless of size or industry, tracking and managing assets is very important.

A manual method of tracking or not keeping a history of asset movements is not sufficient as it will require a large number of employees to carry out the processes and will leave the data vulnerable to poor quality and inaccuracies.

Moreover, these business processes require a relatively long time to be carried out manually in manual calculations as well as in database management. This wasted time diverts attention from other processes such as strategic planning and analysis of fixed assets.

In addition to tracking and accounting for assets, their management also helps in the removal of phantom assets, which can be lost or stolen items.

For these reasons, in our country and in the region, companies have chosen to perform these work processes through information systems such as ERPs.

In the case we are dealing with, the Microsoft Dynamics Business Central system offers the Fixed Assets Module in its basic application, but through the customization that this system allows us, this module can be adapted according to the customer's requirements and achieve all the expectations that the business has towards fixed asset management in Microsoft Dynamics Business Central.

A large part of ERP systems has implemented this module because it is a very important business process, among which we can mention: SAP, Dynamics AX, SAGE FAS, IBM Maximo. (Finance Online, 2022)

The fixed assets module in these mentioned systems is developed in a standard way for all types of industries in order to suit all business requirements as a whole.

During this paper, we will deal with the transfer of fixed assets between companies that are branches of a parent company in the system according to the client's requirements.

Also, currently in the system it is not possible to transfer assets while maintaining the history of these movements.

During the following work, these points will first be analyzed, developed and then implemented in the Fixed Assets module in Microsoft Business Central.

#### *D. Microsoft Dynamics 365 Business Central*

Microsoft Dynamics 365 Business Central is the new generation of Dynamics NAV in the Microsoft suite of products.

The system itself offers small and medium-sized organizations a solution for managing finances, operations, sales and customer service, and is a very good opportunity to easily improve their business processes through the variety of modules the system offers.

The programming language used to develop in the Microsoft Dynamics 365 Business Central application is AL.

To customize (Customize) Microsoft Dynamics 365 Business Central, the management of new developments is carried out by means of one or more Extensions (Modules), also referred to as applications.

Extension is a programming model where functionality is defined as an addition

to existing objects, in this case to existing Base Application objects.

The functionality in this system is encoded in objects and the development model is based on these objects. According to the requirements, new objects can be created and the existing objects can be extended depending on the request. These objects are stored as code, known as application language (AL) code, and are stored in files with the .al suffix. Objects in Microsoft Dynamics Business Central are: Table, Table Extension, Page, Page Extension, Enum, Enum Extension, Codeunit, Report, Report Extension, XMLport, Query, Profile and RoleCenter customizations.

## **Analysis of modules**

### *A. Contracts Module*

**Defining the solution:** The Pre-Sales team has suggested to the client the implementation of the Microsoft Dynamics Business Central package in order to meet the business requirements in each of the modules that the package offers such as Sales, Purchase, Inventory, etc.

It has been suggested to the client based on the ease that the system has in customization / development that for the management of contracts a new module is built in the system which will be managed as a separate Extension. The suggested solution was accepted by the client and the project can proceed to the next phase.

**Analysis:** Management of purchase contracts will be one of the component modules of the system. The module will be built with new objects interwoven with the basic objects of the system to make it possible to follow contracts and in the course of business.

The initial requirements for this business income module are:

#### *Registration of the Contract*

This module will enable the registration of contracts by type (services, goods, investment) with all the main data, terms and conditions. It will also be possible to attach documents to the system.

#### *Contracts in the system*

After registering the contract in the system with the relevant data, the contract will be followed up. Every purchase invoice that will be made for this contract will be linked to the contract, also every payment that will be made for the contract will be linked to the relevant contract.

In this way, the entire cycle of the contract will be followed from the registration, the invoice and its payment.

#### *Changing of contract*

In the contract environment, it will be possible to complete the amendments/ changes in case we have changes in the contract data. The changes can be in the value or in the terms of the contract.

#### *Framework Agreements and Subcontracts*

In the case of framework agreements, the system will manage the main contract and the component subcontracts.

All these subcontracts will be registered in the system and linked to the main contract.

### *B. Fixed Assets Module*

***Determination of the solution:*** Based on the customer's requirements from the Pre-Sales team in accordance with them and the way the system manages fixed assets, it has been suggested to the customer based on the ease that the system has in customization / development that for their management of a new module is built in the system which will be managed as a separate Extension but will use most of the objects and solutions of the system itself, improving them. The suggested solution was accepted by the client and the project can proceed to the next phase.

#### ***Analysis:***

Fixed Asset Management will be one of the component modules of the system. The Fixed Assets module will contain all the options and functionalities needed to manage fixed assets. Through this module, all important information related to assets can be recorded and updated such as tracking of purchase cost, depreciation, current value, maintenance expenses, insurance, revaluations, disposal, employees in loading as well as other information that describes and classifies the asset. The assets will be held in two depreciation methods and the depreciation calculation will be on monthly basis.

#### *Asset Transfer*

In the system, it will be possible to transfer the asset from one warehouse to another through the transfer function. Also, invoices for services performed for an asset will be registered as normal invoices and can be linked to the asset for which the service was performed.

### *Transfer of assets between companies*

In the case of the transfer of assets between companies, two documents will be registered: an exit sheet linked to a transfer sheet and accompanying invoice from the outgoing company and an entry sheet to the Incoming company. Assets will be registered in each company by finance users with the same code.

### *Asset Maintenance Management*

In the asset card, all the dates when services will be done for an asset can be recorded.

### *Revaluation and depreciation of assets*

An asset can add value through a certain repair or modification. This asset revaluation must have influence on the total value of the asset and its depreciation from the moment of revaluation must be done with the new added value.

The same logic applies to asset depreciation. It may happen that after an inspection of the assets, a decision is made that a group of assets should be reduced in value to a certain %. In the system there is an environment that can call a certain group of assets and the value decreases by a certain % or by a certain value.

The module will be built with several new objects mostly interwoven with the basic objects of the system to make it possible to track fixed assets, store their history and move them within a company network.

## **Solution implementation**

### **A. Fixed Asset Module**

For the Fixed Assets module, the analyzed points which we will translate into implementation of this module are the following:

- To enable the transfer of assets between different locations in the system.
- There should be the possibility of changing the responsible person while maintaining the history of movements.
- Enable the creation of fiscal accompanying invoices for the transfer of assets.
- Enable amortization of the value of assets.
- Various setups.



## Technical Design of Fixed Assets Module

### Fixed Asset Transfer table

Create the Fixed Asset Transfer table which will store all the necessary data to create the transfer document of one or several assets from one location to another location. For this table are created these pages: **Fixed Asset Transfer Card, Fixed Asset Transfer List and page part Asset Transfer Lines.**

### Table Fixed Asset Transfer Setup

To create the setup table according to the following structure so that users can define the default values regarding some extra functionalities. (**Page Fixed Asset Setup Card**)

### Table Fixed Asset Transfer History

To add the Fixed Asset Transfer History table, which would contain information about both the invoice header and the invoice lines. For each line of the invoice, at the time of posting, a unique line will be created in the Fixed Asset Transfer History table. (**Page Fixed Asset Transfer History List**)

Also, its needed to modify the existing tables of the Base Application by adding new fields or modifying their structure through extensions.

The fields added to these tables are all displayed in the corresponding List type or Card type pages. The tables: *Transfer Header, Transfer Line, Item Journal Line, General Journal Line* are all tables that store information before posting and accounting in the data system, while the tables *Transfer Receipt Header, Transfer Receipt Line, Transfer Shipment Header, Transfer Shipment Line, Item Ledger Entry, FA Ledger Entry* are the tables where posted records go.

For the information to be saved even after posting, the fields added to the unposted tables must also be added to the posted tables.

### **Example:**

The fields that are added to the Transfer Header table, if we want to save their information even after the posting is done, we must also add them to the Transfer Shipment Header and Transfer Receipt Header tables.

The Transfer Line table fields should also be added to the Transfer Shipment Line and Transfer Receipt Line tables.

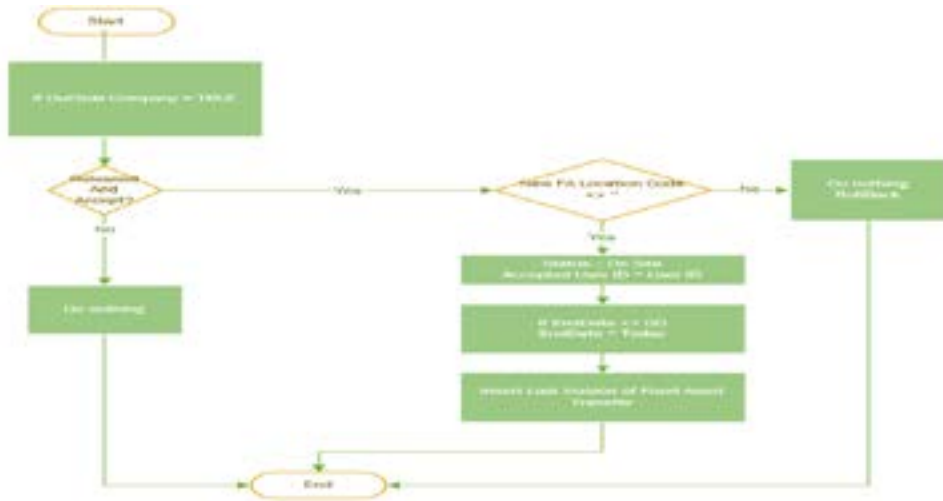
The fields of the Item Journal Line table should be added to the Item Ledger Entry table. The fields of the General Journal Line table, in our case, should be added to the FA Ledger Entry table.

Fields are passed in 2 ways: 1) Transfer fields and 2) Copy from Events

## EXAMPLE OF FIXED ASSET TRANSFER HISTORY TABLE STRUCTURE

Field Name	Type	Length	Relation	Example	Field Description
Entry No.	Integer			112	Incremental number that stores the number of History created.
FA No.	Code	20	Fixed Asset	FA001	Field on which the code of the asset that is being transferred will be inserted.
Old FA Location Code	Code	10	FA Location	Office-4	Stores the location of the asset's origin
New FA Location Code	Code	10	FA Location	Office-1	Stores the location where the asset was transferred.
Start Date	Date			29/06/2022	Saves the date when the transfer process started.
End Date	Date			30/06/2022	Saves the date when the transfer process was completed.
Posting Date Time	Date Time			01/01/2022 14:00:00	Stores the date and time when the asset transfer system is posted/accounted for and the transfer is closed.
Book Value	Decimal			23050.10	Depreciated value of the asset.
Global Dimension 1	Code	20		TRANSFER	Calculation field which displays Global Dimension Code 1 for the selected asset
Global Dimension 2	Code	20		ASSET	Calculation field which displays Global Dimension Code for the selected asset
Old Responsible Employee Code	Code	20	Employee	John Smith	Field that stores the first and last name of the senior worker in charge.
New Responsible Employee Code	Code	20	Employee	John Smith	Field that stores the first and last name of the new responsible worker.
Status	Enum			Open For Transfer, On Site, Released	Stores the status of the transfer state. At the time of posting, it must always be released, otherwise it is not posted
Released User ID	Code	20	User	John Smith	Saves the user who releases the transfer.

EXAMPLE OF AN UML BUILT IN FUNCTION OF THE ANALYZED POINTS  
TO ASSIST IN THE DEVELOPMENT OF THE FIXED ASSETS MODULE



UML for building the release and accept procedure

## B. Contracts Module

For the Contracts module, the analyzed points which we will translate into the modeling of this module are the following:

- To enable the creation and management of agreements in the system.
- To enable in the system the creation and management of the contract with all the necessary data according to the client's request.
- Establish checks if a contract is part of the framework agreement.
- Tracking the progress of the contract with all invoices and payments related to it.
- Creation and management of contract changes through amendments.
- Saving the history of changes.
- Various setups.

### Technical Design of the Contracts Module

#### Contract Table

In the contract environment, it will be possible to manage all the data since the creation and during the management of the contract. (**Page Contract Card/ Contract List**)

### **Change of Contract – Amendment Table**

In the contract environment, it will be possible to complete the amendments/ changes in case we have changes in the contract data. The changes can be in the value or in the terms of the contract. **(Page Amendment Card/Amendment List)**

The contract administration system will enable the following data to be entered for amendments:

- Amendment number
- Description
- Date of amendment
- Object of the amendment
- Date of signature of the amendment

### **Contract Setup Table**

To create the setup table according to the following structure so that users can define the default values regarding some extra functionalities. **(Page Contract Setup Card)**

### **Document Attachment**

For all newly created environments, a functionality has been built, which can be attached to different documents for each document of each of the tables.

### **Table Sub Contractor (Page Subcontractor Card/Subcontractor List)**

Controls in the environment of Sub Contractors:

- If there is no completed subcontractor in this environment, no control will be done.
- If there is only one subcontractor, the value of the field Allocation=100 must be filled.
- If there is more than one completed subcontractor, the sum of the Allocation field values for different Subcontractors cannot be  $< > 100$ .
- If there is more than one Subcontractor No. completed in the table, the same Subcontractor cannot be selected twice.

### **Agreements Table**

In the case of agreements, they will be managed in the system as a contract and the contracts may or may not be linked to an agreement.

If they are under this agreement, these contracts will be registered in the system and will be linked to the main agreement. **(Page Agreement Card/Agreement List)**

## EXAMPLE OF SUBCONTRACTOR TABLE STRUCTURE

Field name	Type	Length	Relation	Example	Field description
Subcontractor No.	Code	20	Related me Vendor No. ne tabelën Vendor	Subcontractor No 1	Subcontractor 1 - The list of suppliers will be accessed and connected to a supplier.
					This is the case when the contract has more than one supplier.
Subcontractor Name	Text	100	Do vije e plotësuar në zgjedhje/ validim/ update të Subcontractor No, nga No. e zgjedhur	Subcontractor 1 Name	Subcontractor Name
Allocation	%			20	The operator's percentage in this contract.

## EXAMPLE OF AN UML BUILT IN FUNCTION OF THE ANALYZED POINTS TO ASSIST IN THE DEVELOPMENT OF THE CONTRACTS MODULE



UML for building Create Amendment procedure

## Implementation Results and Conclusions

In the implementation results chapter, we will analyze the last two phases of the applied Agile method – Microsoft Sure Step, Deployment (Delivery of the final product to the client) and Operation (Preparation of the new work system for the client).

The objectives which are realized in the product delivery phase are Go Live (the client starts normal work in the new system); The training of end users who will use the system is carried out; Various UAT (User Acceptance Testing) are performed and finally the migration of the final data from the system previously used by the client is completed.

In the last phase of the project, which is the operational phase, the closure of the project is carried out by finally transferring the product solution and knowledge to the client. Now the project is transferred from the implementation service to the SLA support along with all the consulting and development documentation (Demiliani & Tacconi, 2018).

The final product organized in two modules in this project has been accepted by the client fulfilling all the requirements given in the initial stages. The customer completes the necessary documentation and takes delivery and use of the product. During the use of the implemented product, the client reports significant improvements compared to the work that was performed in the previous work system.

Among many improvements we can list:

- In the old system, there was no special environment that served for the registration of contracts with all the main data, conditions and relevant terms. Also, the system now allows me to attach documents. Previously, all these data were filled manually and managed on paper by employees, leaving room for error in the filled data.
- In the new system, after the registration of the contract, it can be tracked by linking purchase invoices to this contract for each payment.
- In the new system, it is possible to complete amendments/changes in case there are changes in the contract data in terms of value or terms. It is also possible to save the history of the contract before changes through versions.
- Agreements which will be linked to contracts can be managed in the new system.
- The new system offers the possibility of transferring assets between companies. This movement will be recorded through two documents: an exit

slip linked to a transfer slip and accompanying invoice from the outgoing company and an entry slip in the incoming company.

- In the newly implemented system, there is the possibility of changing the responsible person while maintaining the asset transfer history.
- In the new system, it is possible to create fiscal accompanying invoices for the transfer of assets. These invoices serve as documentation for the persons responsible for the movement of assets.
- In the new system, it is possible to track the costs of maintenance, depreciation, asset placement, management of fixed asset transactions, as well as the generation of various reports and statistics.
- In the newly implemented system, the contracts and fixed assets modules interact with other system modules such as purchase, sale and fixed assets, thus minimizing data duplication and allowing each user role to do its work in the system alone. once in each module.

In the old system, any information was reported to the system only by a few specific users, reducing the work responsibility of many others and bringing an unequal division of responsibilities between users.

The client reports that his requirements have been met for each module developed by achieving their implementation in the system by building the connection with the existing flow of information in the system.

In fulfillment of the client's requirements, the objectives of the implementation of this project have been successfully realized and at the end of this paper I conclude that the solutions implemented for the management of contracts and the transfer of physical assets in this ERP system Microsoft Dynamics Business Central, give answer to the research question raised thus proving the hypothesis.

We can affirm that the implementation in an ERP system of two modules that manage the data of the transfer of physical assets and contracts offers the company more security, history during the storage of information and efficiency during other business processes such as processing, transfer and data distribution.

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# *Development of Tirana's road infrastructure after the 1990s*

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## **Abstract**

*As road transport constitutes the main mode of movement in Albania, road safety remains, of course, a very important aspect. Official statistics, especially for our country, report that it is among the first countries with a large number of car accidents compared to other Western European countries, compared to the corresponding number of vehicles in use per 1000 inhabitants. Both globally and in Albania, over the medium to long term, trends show that globalization and expected population growth will lead to increased demand for transport, exceeding the capacity of SIT's existing systems. Increasing traffic jams, increasing dependence on fuel, increasing pressure on public budgets, and building new infrastructure is not a solution to meet the growing demand for transport from citizens and service providers. The era of vigorous development of science and technology did not have any other options than to include the field of Transport. It has therefore proven to be an innovative alternative to traditional measures to address problems and transport needs, implementation of 'smart' signaling systems, otherwise known as Intelligent Transport Systems.*

**Key words:** *transport, road, Intelligent Transport Systems, infrastructure.*

## Albanian road network. Introduction

The National Road Network under the jurisdiction of ARA is divided into 2 main categories:

- **primary roads** that are numbered from Sh1 to Sh9, plus highways (A1 Milot-Morinë, A2 Tirana-Durrës and the newly built part of the A3 Elbasan-Tirana highway);
- **secondary roads**, numbered from Sh20 to Sh99, as well as some road axes without any reference number.

With the construction of new segments within the Sh1 to Sh9 road network, the old alignments must also be included in the secondary network (e.g., the Sh4 section from Dama to Fier, etc.).

The primary network consists of main roads and some main secondary roads and since it connects all major cities and tourist centers it carries most of the country's traffic.

According to the World Bank's Results-Based Road Safety and Maintenance Project,

the following functional road categories have been identified based on the characteristics of the network under consideration:

**Primary road (P)** means the highways of Albania and the main road corridors.

**Primary-secondary roads (PS)**, means the roads of Albania - except for the primary roads that connect the main cities and tourist centers, as well as lead to border crossings with neighboring countries, within Albania.

*Secondary road (S); AND*

*Albanian Development Fund (ADDF) roads*

According to the Albanian Road Authority (ARRSH), the total length of the National Road Network is estimated at 3,848 km. According to her:

- all primary roads in the main network and about 2/3 of the total length of the secondary network are paved roads.
- about 48% of the total length of the primary network and 21% of the secondary network is on flat land.
- 34% of the primary network and 56% of the secondary road network is in mountainous terrain.
- The National Road Network under the jurisdiction of ARA includes a total of 590 bridges (with a total length of over 10 m).

- This network carries most of the country's traffic.

According to the World Bank, the total length of the National Road Network is slightly higher than 4,288 km, where:

- roads P and PS carry most of the traffic of national roads, with average daily traffic of 6,695 vehicles per day, which carry 76% of vehicle use.
- S and ADF roads have an average traffic of 1,705 vehicles per day and carry only 24% of vehicle usage, even though they constitute 56% of the length of the network.
- the network carries about 4.523 million vehicle-km per year that consumes about 595 million liters of fuel per year resulting in 1.48 million tons of CO2 per year.

**TABLE 1.** Traffic and use of vehicles (Source: World Bank)

Rrjeti	Trafiku		Përdorimi (milion automjete-km)	
	% Rrjetit	Mesatarja	Përdorimi	Përdorimi
	< 1,000 AADT	TDMV	(m auto-km/vit)	(%)
P	5%	7 194	3 064	67.7%
PS	31%	4 212	361	6.9%
S	68%	1 757	1 072	24.8%
FSHZH	100%	751	25	0.7%
Totali	43%	3 916	4 523	100.0%

Since 2007 the Albanian Development Fund (AFDF) - has supported the reconstruction of 142 secondary and local road sections and bridges across the country in a total of 1,170 km in the period 2005-2013.

The ADF impact indicators have been quite positive, such as:

- 60% reduction in travel time compared to the period before the investments.
- 21% increase in traffic volume on reconstructed road sections.
- 8.5% reduction in the cost of public transport.
- reduction in the cost of vehicle maintenance and service for 90% of road users, etc.

## Road condition monitoring

The assessment of the network condition revealed that 83% of the overall network, 91% of the primary and secondary roads and 77% of the secondary and ADF networks are in a stable condition (very good, good or relatively good), which require only periodic and routine maintenance.

According to the World Bank and visual on-site inspections by international consultants, among the signs of poor quality are:

- i) *premature demolition of new asphalts and some structures*
- ii) *the use of different design standards in adjacent sections.*
- iii) *weak and contradictory alerts and other security problems.*
- iv) *non-repairs of electrical equipment.*

**TABLE 2.** National Road Network with conditions and traffic data (Source: World Bank)

Klasifikimi i Rrjetit Rrugor	Kohëzgjatja		Gjendja			
	km	%	Shumë mirë ose Mirë	Relativisht mirë	Keq ose Shumë keq	Mesatar IRI <sup>19</sup>
P	1 167	37%	66%	24%	10%	4,5
PS	235	7%	62%	34%	3%	4,6
S	1 672	53%	38%	37%	25%	6,4
FSHZH	90	3%	100%	0%	0%	3,5
<b>Totali</b>	<b>3 164</b>	<b>100%</b>	<b>52%</b>	<b>31%</b>	<b>17%</b>	<b>5,5</b>

## The functional design of Intelligent Transport Systems

Intelligent transport systems (SIT) alone cannot solve all transport problems. Not even any other single technology can solve this. SIT applications will not reduce demand for mobility and access, nor increase highway capacity. But SITs can provide transportation agencies with additional tools to manage transportation challenges while maximizing the safety and efficiency of existing infrastructure.

SIT application requirements can affect many aspects of planning and design, including earthworks, hydraulics, structures, traffic engineering and environmental disciplines, and early deployment of SIT can help manage traffic during project implementation. Therefore, the integration of SIT in the planning and development processes of the project is critical to building and ensuring support for its investments.

SIT devices vary from simple traffic control and passenger information systems to high-speed automatic incident detection devices and cooperative vehicle-to-infrastructure systems.

A functional Intelligent Transport Systems project needs to be undertaken to establish the requirements on which the detailed project is based. The SIT functional design for any new SIT capacity should include:

- Identification of the main transport monitoring subjects and main roads.
- Integration with existing transport systems and main roads
- Choosing the technology that is suitable for the purpose
- Procurement of system components based on defined standards.
- Cost of administration, maintenance, and management throughout the life of the product.
- Security requirements, by the standards.
- The project allows for high availability
- Prevention of environmental damage
- Devices that are physically and technologically robust and reliable.

### *Supporting infrastructure*

It is important that road designers approach the provision of SIT supporting infrastructure from a holistic point of view. This includes consideration of SIT applications related to the project, which may be outside the scope of the current project.

The design of the SIT must consider several parameters and technical data, such as: road geometry, landscape design, drainage systems, road structures, other street furniture such as static signs, lighting, electrical service plants, public services, and supply, etc. some specific requirements of SIT.

This will allow addressing conflicts that may arise regarding the permitted spacing of SIT equipment, channel routes and long distances to other road services, etc.

SIT devices require power and reliable communications links to operate efficiently. The civil infrastructure must allow the transmission of SIT electrical and communication cables. Designs should allow for piping, pits, ducts, antennas, cabinets, and layers or structures as needed. Where possible, SIT equipment and supporting infrastructure (including manholes and drains) should be located on external thresholds.

Consideration of possible requirements for future road changes (such as road widening, emergency lane routing and/or separation for differential speed limits) should be made in the SIT design. While the granting of SIT applications may not



be required immediately, land acquisition and civil works should be undertaken to allow these to occur easily in the future.

### *Intelligent transport systems*

The main reasons for implementing SIT include:

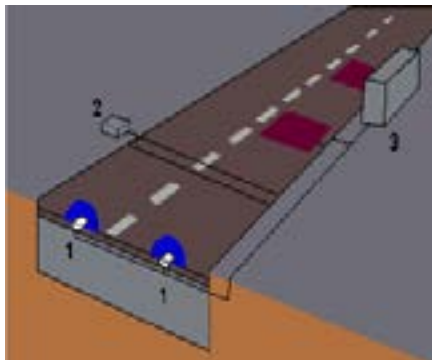
- improving road safety.
- improving the efficiency of the road network.
- improving the efficiency of the transport system.
- reducing the environmental impacts of the transport system.

These systems depend on many different technologies and equipment, including vehicle detectors, message signs, display monitors, closed circuit television (CCTV) and telecommunications networks.

### **Road mounted vehicle detectors**

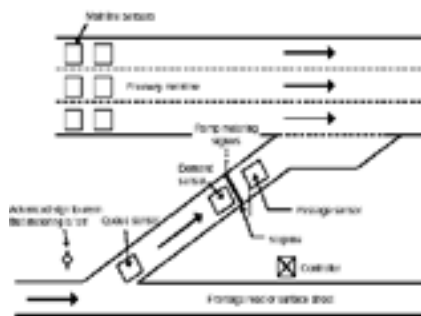
Newer alternatives in off-pavement (non-invasive) sensors include: Video images, Doppler radar Acoustic sensor

- Type: 1. Magnetic sensors,
- 2. Pneumatic Tube/ Detectors
- 3. Inductive Loop/ Detectors



Type: 4 Piezoelectric sensors

Road mounted vehicle detectors



VDS layout in a highway application

Strategic planning of VDS design in urban areas may be more beneficial when provided for future expansion. This includes both the detection equipment and the real estate required for this equipment.

### *Vehicle calculators/classifiers*

Vehicle controllers/classifiers collect and record traffic volume and vehicle classification data. Classification may also be an additional feature of the previously described vehicle detection systems. Classification can be done based on speed, vehicle length and/or the number of axles. The basic classification according to the number of axles and the distance between axles or groups of axles is widely adopted.

The system considers vehicles and combinations of vehicles up to sixteen axles. Data capture can include each vehicle's travel lanes, lane data, date, time of day, and classification.

VEHICLE CLASSIFIER



VEHICLE CLASSIFIER



### **Components of vehicle calculators/classifiers may include:**

- a data entry device capable of collecting, processing, storing, and transmitting vehicle data.
- axle sensors to detect vehicles, vehicle speed, and axle spacing - sensors can be pneumatic tubes, piezoelectric sensors Communication interface to allow local/remote connection.
- Field cabinet and all necessary interconnect cables and various materials to make an operational system.
- Access to maintenance.

### *Closed-circuit television camera systems*

Closed-circuit television (CCTV) systems provide a means by which road agencies can effectively monitor the road network, and detect and respond to incidents.

Real-time CCTV coverage allows Traffic Management Center operational staff to immediately identify incidents as they occur as the time an incident is detected/verified affects response time and effectively minimizes the number of traffic disruptions as a result.

Example of placement of roadside CCTV camera system.



Cameras are typically approved for road coverage with this service. The main components in the terrain field for a route include an SIT booth, camera pole, base, camera, and bracket.

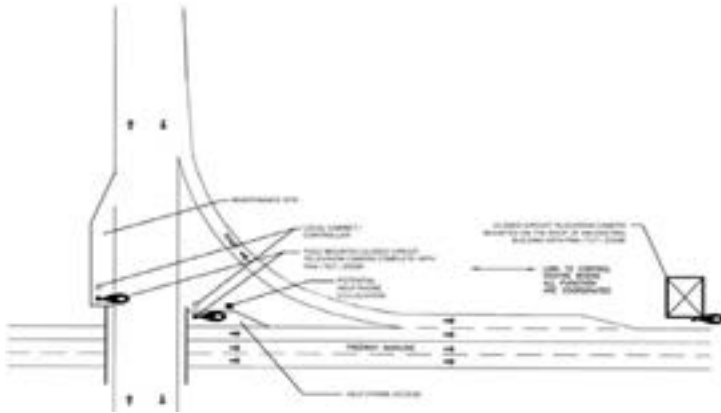
Typical incident verification includes:

- confirmation that an incident has occurred
- determining the location and exact direction of travel and
- obtaining and assessing the nature and as many additional details as possible about the incident.



Cameras are usually installed outside the travel portion of the road so that all segments of the highway system are within view. As a minimum, there should be CCTV coverage of carriageway traffic (including underpasses), emergency stop exits, entry and exit ramps and associated intersections. Finding a good CCTV site requires an extensive investigation of proposed camera locations.

CCTV PLAN IN A HIGHWAY APPLICATION



### Road weather monitoring

Weather monitoring stations (RWS) provide valuable information regarding the state of road weather conditions and are an important element in improving the safety of travelers. Road weather stations monitor conditions such as road temperature, precipitation level, wind speed and wind direction. This information can be transmitted to a Traffic Management Center (TMC) and/or in a warning message displayed on the selected VMS. Speed limits may change accordingly in response to precipitation, wind speed or other conditions monitored by environmental sensors.

EXAMPLE OF A ROAD WEATHER MONITORING STATION



As physical elements that make up the weather monitoring system, we can mention:

- Weather detector, with components on or off the road superstructure
- Mounting post
- Field cabin
- Sewers for energy and communication as needed
- Access to maintenance

### *Phone helplines*

#### Purpose

Drivers involved in an accident or trapped by a damaged car may require help or assistance. Helplines play an important role in improving passenger safety and protection. They provide a means of establishing direct communication with traffic management center operators.

In both cases, rapid and efficient dispatch of resources is critical to reducing traffic congestion and improving public safety. In the urban / highway environment, the location of the helpline should be secured with CCTV surveillance.

#### PHONE HELPLINE



#### Phones and help for use:

Call everyone about the road environment, Growing pole/structure, Access to the telecommunications network , Emergency lane, in which a vehicle can stop safely.

## Variable message signals, vms



VMS are an essential element of passenger information systems and are used to provide advanced information to drivers. VMS can be placed at the start of steep slopes or at tunnel entrances to attract attention when safe passage may be compromised.

VMS messages are advisory rather than regulatory and typically relate to: • *accidents/incidents, heavy traffic, road work, weather conditions, special events, road safety messages general transport messages.*

*A VMS implementation can consist of:* contour of signage, maintenance holder, Support structure and foundation, equipment holder, field cabinet and base , Display of VMS, Electricity supply, communications, electrical systems, control systems, access to maintenance.

### Signage size

The size of the sign usually depends on the speed of traffic on the road, the distance of sight and the stability along the road.

Type	Speed (km/h)	Dist min e VIEWING	Length min Font	The width of periphery
A	<60	100 m	150 mm	125 mm
B	60÷90	160 m	330 mm	158 mm
C	>90	250 m	440 mm	220 mm

Character size about speed and sight distance

### Information signs on road conditions

Road condition information signs (RCIS) are a variant of CMS and/or VMS. They are placed in strategic places on the road network and show the condition

of passing road segments of interest to the driver. These routes may be subject to occasional flooding or load restrictions.

Each sign may consist of several VMS or modules where each module indicates whether a part of the road is open, closed or subject to conditional access such as load limits that may be imposed due to environmental conditions.



An RCIS implementation may consist of:

- a table complete with variable message tokens
- Support structure and foundation
- field cabin and foundation
- energy supply including solar energy
- communications
- electrical systems
- control systems
- access to maintenance.

### *Variable speed limit / lane control signals*

Speed limits can be changed in accordance with weather conditions etc., as well as to allow for maintenance activities or as a way of relieving overload on adaptive speed control systems.

Periodic speed limit changes are required in school zones. These SIT applications have increased the need for active variable speed limit signs (VSLS).

A VSLS can have a dual function in that it can be a VSLS as well as a lane control sign (LCS).

A VSLS / LCS installation can consist of:

- an outline of the signage
- Support structure and foundation
- Maintenance and access for signs and installations
- Field cabin construction group controller as required and other equipment.

## *Rampash measurement systems*

Traffic congestion occurs when travel demand exceeds capacity. This congestion is a common occurrence on parts of the motorway network. Ramp metering aims to limit the number of vehicles entering the highway from the entrance ramp at certain time periods so that the flow on the highway is kept under control.

Ramp metering uses three aspects (red, yellow, and green) of traffic signals on freeway ramps to control the rate of vehicles entering the freeway.

## *Weight measurement systems, weigh-in-motion (WIM)*

Weigh-In-Motion (WIM) systems improve the efficiency of processing commercial vehicles at inspection stations. A WIM system uses sensors installed on a road to measure the weight of moving vehicles as they pass.

The WIM system can provide truck inspection station personnel with the data to selectively focus on trucks that are potentially at risk of being overweight. This reduces the compression and accumulation lengths of trucks entering the truck inspection station. WIM systems typically consist of:

- mat or piezoelectric tape-type sensors (can be used in both permanent and temporary installations)
- Lower speed lane (the technology for WIM systems is relatively mature, however, they are required to be installed in places where trucks travel at lower speeds)
- special WIM zone road layer construction to maximize accuracy and layer life
- Variable Message Signaling (CMS) for truck diversions
- a sewer system for energy and communication
- Controllers cabinet
- access to maintenance
- CCTV for monitoring
- Heavy vehicle inspection station (optional).

## *Automatic plate number recognition systems*

Automatic number plate recognition (ANPR) systems use optical character recognition to capture number plate information.

ANPR provides an accurate method through which travel time monitoring and overall network performance can be verified. ANPR can be used for enforcement in WIM applications and other police tasks.



ANPR systems may use inductive detector loops, lasers, or other sensors as part of their image capture mechanism.

#### POLE-MOUNTED AUTOMATIC WIRELESS LICENSE PLATE NUMBER CAPTURE SYSTEM



The equipment required to implement an ANPR may consist of: equipment that provides infrared illumination, video capture, sewers for energy and communication, access to maintenance, lightning protection, loop/detection sensors as needed, field cabinets, pillars and gantries.

### Principles for the specification and deployment of SIT

Approval of specifications, issuance of mandates for standards and selection, and deployment of SIT applications and services shall be based on a needs assessment involving all stakeholders and shall be consistent with the following principles. These measures should:

- (a) **Be effective** - make a tangible contribution towards solving the main challenges affecting road transport in Europe (e.g., reducing congestion, reducing emissions, improving energy efficiency, achieving high levels of safety and protection including dangerous road users).
- (b) **To be cost-effective** – optimizing the ratio of expenses in relation to outputs in relation to the achievement of objectives.
- (c) **be proportional** - provide, when appropriate, for different levels of service quality and accessible placement, taking into account local, regional, national and European specificities.
- (d) **supporting continuity of services** - to provide connected services throughout the territory of the country, in the trans-European network, and where possible in its external borders, where its services are located. Continuity of services must be ensured at a level adapted to the

characteristics of transport networks in the connection between countries, and when appropriate, regions with regions and cities with rural areas.

- (e) **distributor interoperability** - ensure that underlying business systems and processes have the capacity to exchange data and share information and knowledge to enable their effective service delivery.
- (f) **backward compatibility support** - to ensure, where appropriate, the ability for its systems to work with existing systems that share a common purpose, without impeding the development of new technologies.
- (g) **respect for the characteristics of the network and the existing national infrastructure** - considers the inherent differences in the characteristics of the transport network, in the sizes of traffic volumes and road conditions.
- (h) **promote equality of access (right)** - do not hinder or discriminate against access to SIT applications and services by vulnerable road users;
- (i) **mature support** - demonstrates, after appropriate risk assessment, the new capabilities of SIT systems, through a sufficient level of technical development and operational exploitation.
- (j) **provision of positioning and time quality** - use of basic satellite infrastructures, or any technology that provides equivalent levels of accuracy for applications and services that require globalization, continuity, timing and positioning of accurate and guaranteed SIT services -'s.
- (k) **facilitates intermodality** - takes into account the coordination of different modes of transport, when appropriate, for the deployment of SIT;
- (l) **respect for coherence** - takes into account existing rules, policies and activities of the EU, which are important in the field of SIT, in particular in the field of standardization.

Factors causing delays in the deployment of SIT in Albania include:

- Lack of strategy and policy approach regarding the implementation of SIT
- Lack of funds.

The strengths for the status towards the increasing deployment of SIT in Albania are listed below:

- Albania can create suitable conditions for the acceleration and coordination of the deployment of SIT
- Preparation of updated legislation for the establishment of SIT
- Plan and integrate the general components into a realistic scheme
- Use “best practices” for designing up-to-date technologies to support SIT deployment

The following issues should be addressed on behalf of the responsible actors:

- Ensuring an adequate legislative framework for the establishment of SIT, laws, and Government decisions for this purpose, in coherence with the EU Legislation and the SIT Action Plan and the SIT Directive in priority areas
- Establishing a strategy for the deployment of SIT by the EU Directive 2010/40
- / EU of the European Parliament and of the Council of 7 July 2010, EU documents on the subject.
- Creation of an administrative structure/department at the national level, which will promote, support, develop and monitor the deployment of SIT
- Initiation of projects for the deployment of SIT in cities, especially in Tirana in the first place
- Promotion of cooperation between central and regional authorities and between public and private organizations with defined roles and responsibilities
- Financial support for projects aimed at establishing SIT
- Promotion of public-private partnership for research and deployment of SIT

## Sites in road transport

The only SIT platform in Albania, for road transport, is the Urban Traffic Control Management System for the city of Tirana.

The main goal of the system is to implement an advanced architecture of SITs, capable of managing the complexity of the traffic situation in Tirana, implementing optimal control of the main traffic lights of the city of Tirana, ensuring traffic surveillance of the main roads and an info mobility platform (via variable message panels, Web, SMS).

### MAP OF THE INSTALLATION OF TRAFFIC LIGHTS IN THE CITY OF TIRANA







MAP OF THE INSTALLATION OF VARIABLE MESSAGE PANELS (VMS) IN THE CITY OF TIRANA



## MAP OF THE INSTALLATION OF CAMERAS IN THE CITY OF TIRANA



### Road safety

Road safety is the foundation of accident prevention, which unfortunately in Albania have a constantly increasing trend and are more than 2 times higher than in developed countries. This is a major social concern and road accidents are an important health and economic problem facing our country.

Spending on road safety should be seen as a high priority and as an investment but not a cost so we all need to work together to solve this urgent issue.

Road safety represents a key component of this responsibility, which is directly related to KNSRr's vision of "Simple and safe transportation for all."

Number	Year	Road incident	Killed	Wounded
1	1992	574	372	449
2	1993	591	375	547
3	1994	559	421	535
4	1995	399	306	333
5	1996	381	257	258
6	1997	370	266	319
7	1998	434	308	339
8	1999	468	274	383
9	2000	429	280	336

10	2001	400	297	250
11	2002	328	250	228
12	2003	363	267	250
13	2004	804	315	804
14	2005	850	308	875
15	2006	1018	277	1051
16	2007	1254	384	1344
17	2008	1208	303	1256
18	2009	1465	378	1455
19	2010	1564	353	1716
20	2011	1876	322	2150
21	2012	1870	334	2235
22	2013	2075	295	2503
23	2014	1914	264	2353
24	2015	1992	270	2422
25	2016	2033	269	2510
26	2017	1978	222	2389
	Shuma	27197	7967	29290

## SWOT analysis for Albania

In order to see the impact and validity of the application and use of Intelligent Systems in our country as well, following the tabular data above as well as those in the Annex, by asking their question, we will develop their analysis. SWOT with control as below.

### *Strengths*

- There is a National Transport Plan.
- All classic modes of transport are carried out in the region: land, sea, rail, and air; Basic transport infrastructure exists.
- The intersection of the two most talented Corridors: North-South and East-West; The connection of this corridor with the Pan-European Corridors of transport.
- Increased mobility in the region.
- Increasing private sector services in all modes of transport; Expansion of interurban and urban bus lines.
- Many sea and land transport companies.

## *Disadvantages*

- Unsatisfactory management of urban traffic and signage.
- The poor condition of rural and urban roads and their maintenance; Lack of opening for parking/parking in the second row.
- Lack of roads for pedestrians and lanes for cyclists.
- The inefficiency of freight carriers with pick-up trucks, vans, and trucks; Not high standards of road doctors, the large number of accidents,
- average driving skills, pedestrians in crosswalks; Limited access in rural areas to public transport.
- Education at low levels with traffic rules.
- A small number of exchanges of transport modes.
- High level of environmental pollution from old and heavy vehicles; High and unnecessary number of heavy vehicles in urban areas.

## *Opportunity*

- The best combination of transport types (road, sea, rail, air).
- Improving connections between the main elements of transport: port-railway, airport-highway.
- Improving traffic management at all levels; Incorporating transport planes into new urban plans; Improving public transport at all levels; Removal of unnecessary heavy vehicles from urban areas;
- Insurance policies for motor vehicles that consider the degree of environmental pollution and the encouragement of more ecological means and ways.
- Training for traffic management and road safety; a better combination of transport modes.
- Improving the financial management of public transport (price-subsidy); Increasing the participation of private business in transport investments.
- The use of Intelligent Transport Systems for the coordination of different modes of transport, for increasing road safety and traffic management

## *The Risks*

- Increasing the number of traffic jams; Lack of plans and their implementation; Increase in the number of tools by about 30% per year; Insufficient parking;
- Failure to improve safety, reduce accidents, fuel quality, and pollution levels (health costs);
- Failure to improve the road network.

- Failure to improve public transport (in quantity and quality), abandonment of railway transport.
- Investments in transport may not be compatible with development plans.
- Increasing the number of unnecessary heavy vehicles in urban areas.

### *Recommendations*

Based on the SWOT analysis, these main factors for the successful development of transport in the Region and the implementation of the SIT result

- Improving public transport between cities and municipalities, especially high-speed lines.
- Encouraging the use of bicycles and discouraging the use of heavy vehicles that increase environmental pollution.
- Redesigning the road network, with the shortening of the main internal and external lines and the displacement of heavy vehicle traffic outside urban areas.
- Better integration of traffic management, improving the use of existing transport networks, with the implementation of Intelligent Transport Systems.
- Improving road safety and educating the community about it.
- Improvement of urban parking lots.
- Improvement of road maintenance.
- Improving connections between different modes of transport.
- Improvement of rural roads
- Review of transport policies focusing on SIT

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# *Study on the integrated use of photovoltaic plants (PVT) for the production of electrical energy and heat using heat pumps (PN-PT)*

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*MSc. Ing. Luciano ZEFI*<sup>1</sup>

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## **Abstract**

*Every year, the use and application of photovoltaic systems in residential buildings is increasing for the purpose of producing electricity, especially in isolated areas or for those that lack energy. Photovoltaic systems to produce electricity are safer and more economical systems. Albania's total energy problems include those related to renewable energies, both on the supply side and on the consumption side. In this paper, the topic of integrated photovoltaic systems of energy and heat production is addressed. The theoretical and experimental analysis of the behavior of the integrated Heat Pump - PVT system is very important to increase the efficiency of the use of renewable energies and therefore contribute to the decarbonization of the environment. The research carried out offers not only the increase in the rate of use of renewable energies, but also the optimization of integrated PN-PVT schemes, which can be used in the housing sector.*

**Key words:** *Photovoltaic, systems, residential buildings, energy, biomass*

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## Methodology

- Obtaining data from various studies and reports of meteorological and statistical data in the region of Tirana.
- Advice and guidance from the subject leader.
- Using Polysun software for simulating schemes.

## Main sources of energy

- Solar energy
- Wind energy
- Energy from biomass
- Energy from biogas
- Geothermal energy
- Power plants
- Water energy (hydro power plants)

## Albania's potential for renewable energy

The territory of Albania lies in the western part of the Balkan Peninsula on the eastern coast of the Adriatic and Ionian seas, thanks to this geographical position, Albania belongs to the Mediterranean climate zone with hot and dry summers, long sunny days, and mild winters.

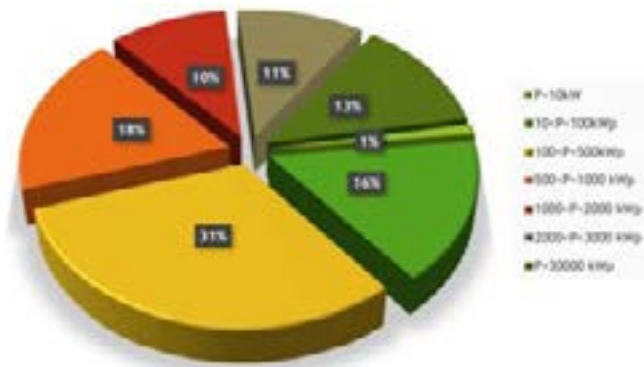
Albania has a good solar energy regime. Also, the intensity of the rays during these days is similar to the countries that have started to use solar collectors on a large scale for heating sanitary water.

In the territory of our country, we have a considerable energy potential from solar radiation, where many areas are exposed to a radiation ranging from 1185 kWh/m<sup>2</sup> per year to 1700 kWh/m<sup>2</sup> per year.

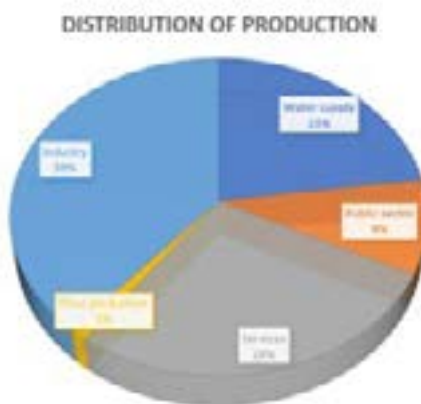
The integration of solar thermal energy for the supply of warm water in the household and service sector was among the measures developed by the National Action Plan, approved by the Albanian government in January 2016.

Solar panels for hot water are one of the most promising technologies for reducing electricity and wood consumption, with a significant contribution to reducing greenhouse gas emissions.





Grouping of consumers according to the required production capacity of energy from photovoltaic plants.



Distribution of production capacity by sector in kWp for consumers over 500kWp

## The influence of temperature on the electrical performance of the photovoltaic module

The operating temperature plays a central role, because both the electrical efficiency and the power output of a photovoltaic module depend linearly on the operating temperature.

The higher yield of crystalline silicon cells will result in a higher electrical yield and a higher electrical-thermal ratio of the panel than in the case of amorphous cells.

Experimental measurements for the liquid fluid panel and the air collector panel for both cases with amorphous cells and crystalline silicon cells found that at zero temperature, for the liquid collector, the efficiency of the prototype with crystalline cells was 55% and the prototype with amorphous cells 60%, while for the air collector the prototype with crystalline cells was 38% and the prototype with amorphous cells 45%.

The effect of temperature on the electrical yield of a photovoltaic cell / module can be obtained using the basic equation:

$$P_m = I_m V_m = (FF) I_{sc} V_{oc}$$

## **PVT systems and their construction**

The combined photovoltaic panel represents a combination of the photovoltaic panel intended only to produce electricity, with the solar thermal panel.

It is found in various constructive realizations. So, it is produced with or without protective glass. Depending on the cooling fluid, the PVT panel can be air-cooled, liquid-cooled or combined cooling.

Depending on the movement of the fluid stream, the PVT panel is unidirectional or bidirectional.

The PV panel itself depending on the material of the photovoltaic cells, can be:

- Silicon in crystalline form
- With a thin layer, which are: o As amorphous; o CdTe, o CIGS
- With very thin film, which are technologies still in the experimental stage, before they become commercial.

## **Heat pump (PN) integrated PVT systems in buildings**

The object of this study are PVT systems integrated with PN in buildings, with the aim of determining the optimal schemes of PN integrated with the use of renewable energies, primarily solar.

Studies and realizations have proven that PVT systems can be integrated with PN in various residential and service buildings.

There is interest in the use of PVT systems, even integrated in buildings, both in the case when they will be separate, and in the case that they are combined. In the latter case, the use of materials and energy production indicators are more useful.

In these cases, the heat pump is only integrated with industrial processes, in contrast to the integration of the heat pump in buildings, where the integration is done with solar PVT systems.

PVT systems produce both electricity and thermal energy. The latter, being of low potential, can be used for: The heating of the environment; UNGS.

### Principle scheme of PN-PVT operation

PVT panels, when integrated into PN systems for use in buildings, have relevant design methodologies. The main parts of this system are:

1. PVT panel; - PN.
2. Thermal storage.
3. Control and management system.

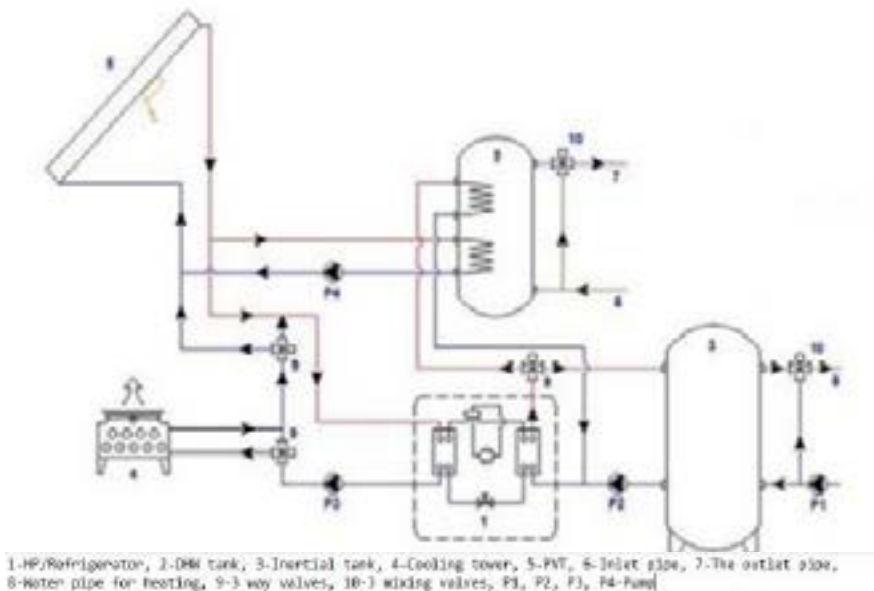
Combining PN with PVT is a useful way to obtain warm water used in buildings for heating and or sanitary water.

PN integration with PVT systems can be:

- a. Direct- when the solar panel serves as an evaporator for PN.

Such a system is simple and compact. In this case the combined system can only be used for heating, but it cannot be used for cooling, since the panel cannot play the role of a condenser.

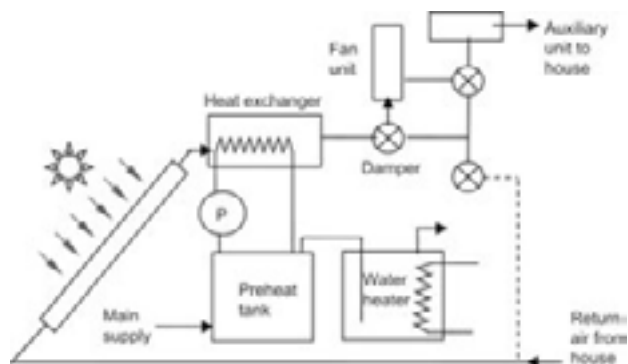
- b. Indirect – when the solar panel does not serve as a PN evaporator.



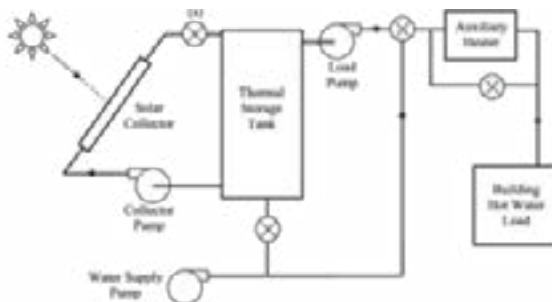
Both subsystems are individual but combined. This combination can consist of their connection in:

- Parallel. In this case, the PN is put into operation when the PVT system does not meet the demand for heating. Even though in the scheme the case of PN work with external air source is given, it is also possible to PN scheme with other sources such as geothermal ones etc.
- Seri. In this case, when the PVT does not meet the energy demand, the PN is put into operation, where the accumulator serves as an evaporator for.
- Parallel, but only of evaporators or as it is otherwise called the scheme with two energy sources. In this case, when the PVT panel does not meet the demand for heating through the accumulator, the second evaporator of the heat pump is also put into operation. PN works with two evaporators connected in parallel.

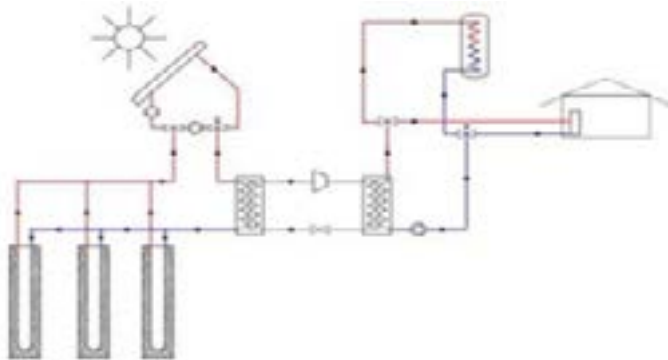
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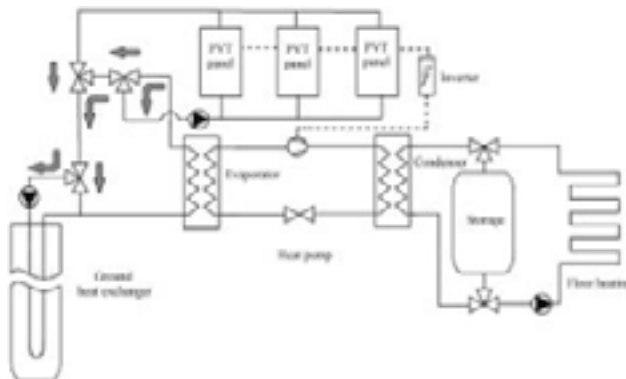
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## INTEGRATED PN SCHEME WITH PVT& GEOTHERMAL)



## HEAT PUMP WITH THREE INTEGRATED SOURCES WITH PVT PANELS



## PN and PVT system evaluation indicators

### *PN performance indicators*

The efficiency of the PN in heating or cooling is expressed through the performance coefficient, respectively  $\epsilon_n$  or  $\epsilon_f$  :

$$\epsilon_n = COP = \frac{Q_1}{W_R} = \frac{\dot{Q}_1}{\dot{W}_R}$$

$$\epsilon_f = EER = \frac{Q_2}{W_{cikli}}$$

## Electrical and thermal efficiency of the PVT system

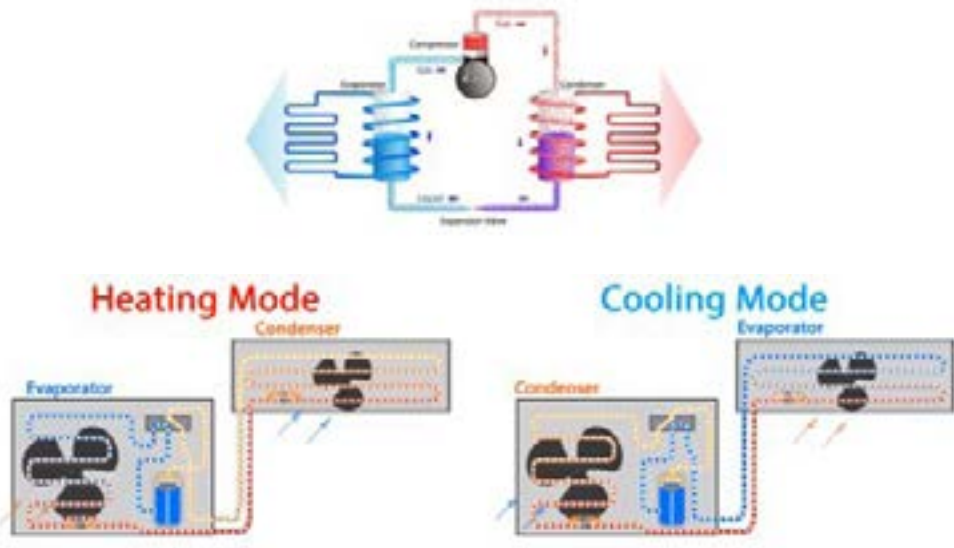
The total electrical and thermal efficiency of the PVT system is expressed as the sum of the thermal and electrical efficiency of the panel:

$$\eta_{PVT} = \eta_e + \eta_t \quad \eta_{PVT} = \frac{\eta_e}{\eta_{el,ref}} + \eta_t$$

where  $\eta_{e,ref}$ , is the reference electrical efficiency, 0.413 can be obtained

## Heat pumps

A heat pump is a system that serves to transfer heat from a lower temperature source to a higher temperature source. Most modern heat pumps use the reverse thermodynamic cycle.



The photovoltaic / thermal hybrid system has the following applications:

- Air heating system;
- Water heating system;

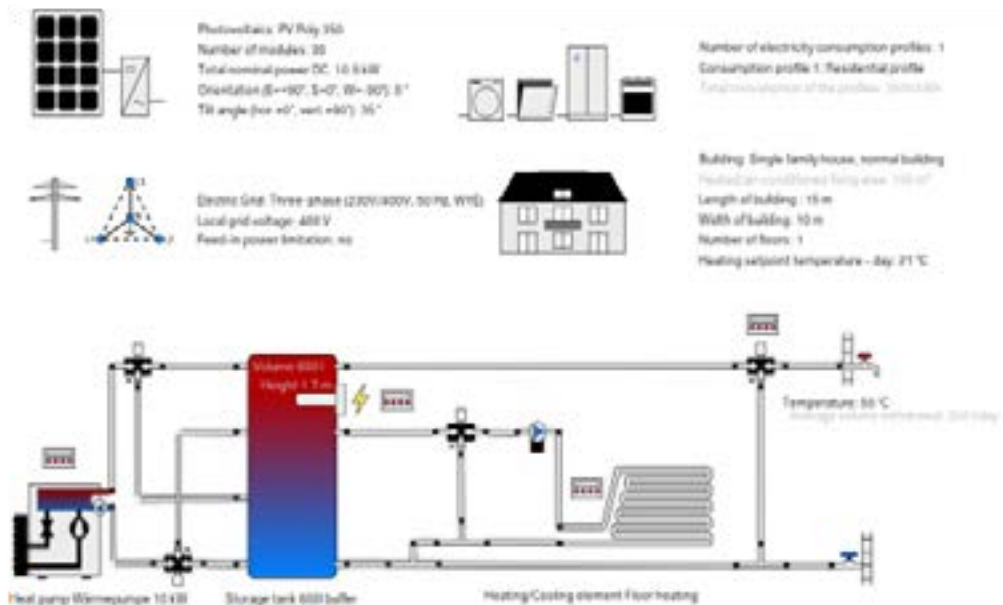
## 1. Air PVT system

PVT air collectors are used to produce electricity and heat air at the same time. Hot air is used for space heating and/or drying purposes.

## 2. PVT systems with water

The solar water heating system consists of a collector, an insulated tank and pipe connectors. The solar panel of the solar water heater collects solar energy with a black absorber. The heat collected by the absorber is transferred to the water flowing through the absorber and stored in the tank.

### FIRST SIMULATION CASE: SPACE HEATING + DOMESTIC HOT WATER (PHOTOVOLTAICS + HEAT PUMP)



Functions:

- Heating/Cooling system with Fan Coil.
- Production of UNGS (hot sanitary water);
- Production of thermal energy from the PVT panel.
- Production of electricity from the PVT panel.

This type of scheme is mostly used in residential buildings with a high degree of thermal insulation with an area ranging from 150 to 350 m<sup>2</sup>.

These typologies, in terms of plant engineering, need UNGS (domestic hot water), electricity, heating and cooling, all of this in support of energy saving, environmental protection and CO<sub>2</sub> reduction.

To achieve these goals, there should be combinations of water-to-water heat pumps, air-to-air heat pumps combined with PVT panels.

The use of solar energy, to have an optimal yield utilization of PVT panels (Combined Photovoltaic and thermal hybrid panels together) is done with a solar fraction of 40-60%.

### *Overview of system data (annual values)*

Total system fuel and/or electricity consumption [E <sub>tot</sub> ]	-9202.3 kWh
Total electricity consumption [E <sub>cs</sub> ]	5903 kWh
Total energy consumption [Q <sub>use</sub> ]	9112 kWh
Seasonal performance factor (SPF-SHP)	3.8
Primary energy factor	0.3

### *Overview of photovoltaics (annual values)*

Total gross area	53 m <sup>2</sup>
Total rated power DC	0.5 kW
Performance report	76 %
Annual specific yield	1439 kWh/kWp
Savings e CO <sub>2</sub>	8103 kg

### *Overview of electricity (annual values)*

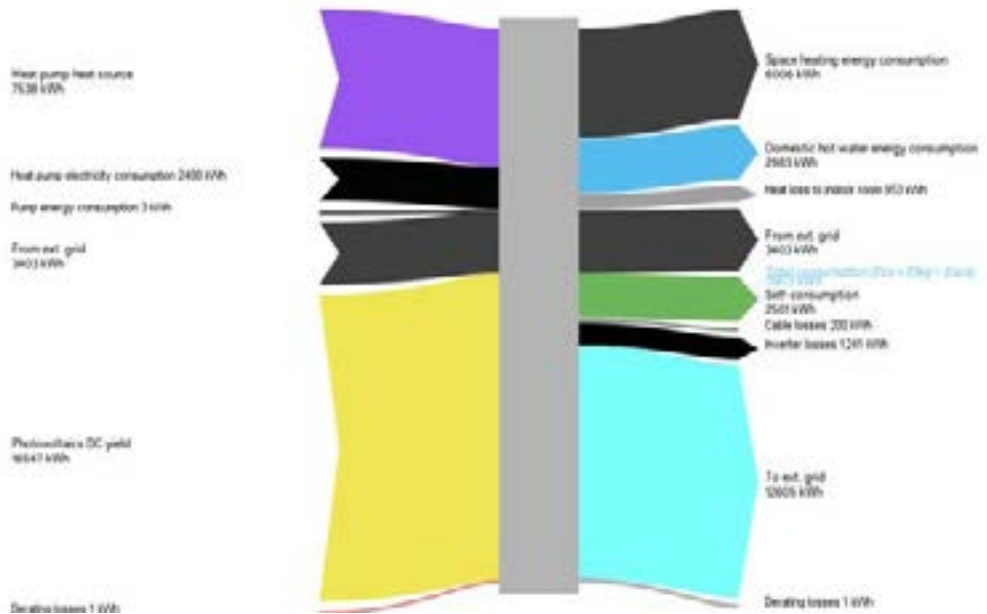
Annual consumption	5903 kWh
Self-consumption	2501 kWh
Self-consumption part	16.6 %

### *Heat pump overview (annual values)*

Seasonal performance factor for the air-to-water heat pump	4.1
Total electricity consumption during heating [E <sub>aux</sub> ]	7538 kWh
Total energy savings.	2400 kWh

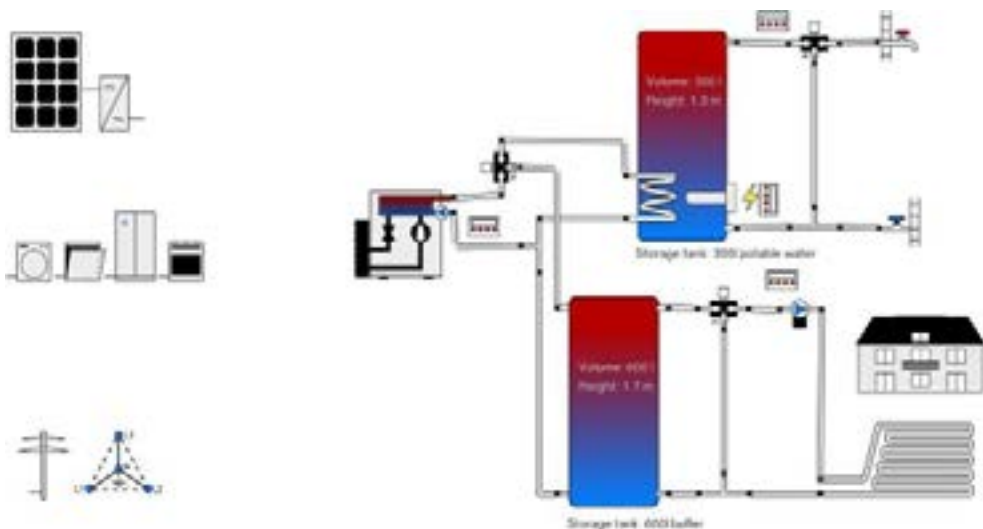


## Energy flow diagram (annual balance)



## The second case of the simulation

Space heating + domestic hot water (photovoltaics + heat pump + two accumulators)



The functions of the scheme are:

- Heating/Cooling system with Fan Coil with P.N.
- Production of hot sanitary water + P.N.
- Production of thermal energy from the PVT panel.
- Electricity production from PVT panel.

In this scheme, the heat pump is integrated, which must meet the needs for ensuring the temperature of the UNGS accumulator and through the diversion by means of 3 (three) way valves, having command from the monitoring and control system, provides heating or cooling in the villa.

#### *Overview of system data (annual values)*

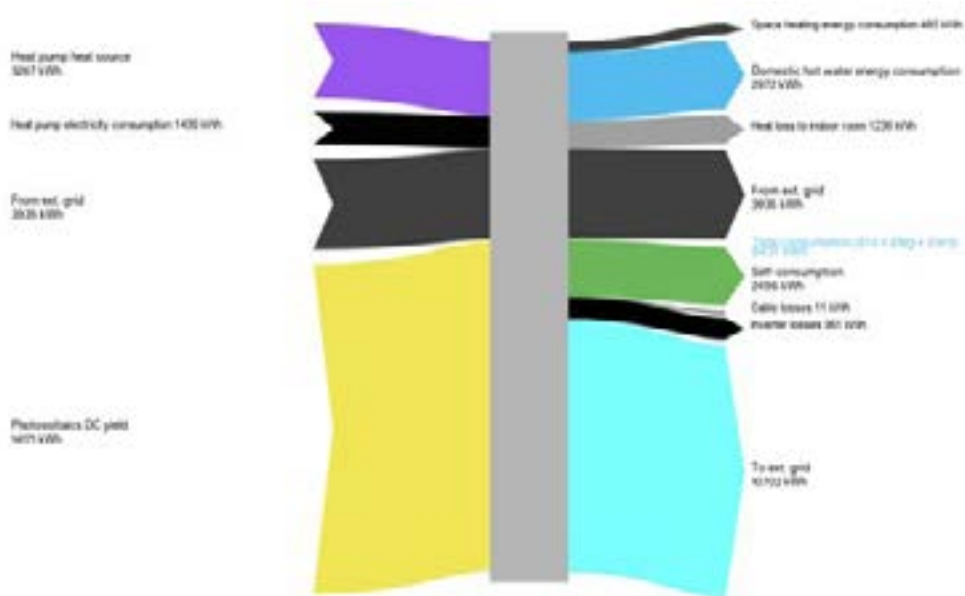
Total system fuel and/or electricity consumption [Etot]	-6767.5 kWh
Total electricity consumption [Ecs]	6431 kWh
Total energy consumption [Quse]	3515 kWh
Seasonal performance factor (SPF-SHP)	2.5
Primary energy factor	0.49

#### *Overview of photovoltaics (annual values)*

Total gross area	69.2 m <sup>2</sup>
DC power output [Qpvf]	14170.9 kWh
AC power output [Qinv]	13198.2 kWh
Performance ratio	77.7 %
Annual specific yield	1466 kWh/kWp
CO2 savings	7080 kg

#### *Overview of electricity (annual values)*

Annual consumption	6431 kWh
Self-consumption	2496 kWh
Share of self-consumption	18.9 %
Self-sufficiency rate	38.8%
Heat pump overview (annual values)	
Seasonal performance factor for the air-to-water heat pump	3.3
Total electricity consumption during heating [Eaux]	1430 kWh
Total energy savings	3267 kWh



## Conclusions

Albania has great potential in terms of solar energy, which we can use to obtain electricity as well as thermal energy, through simple plants.

The integration of PVT Plants with Heat Pump can be realized both in the residential sector and in the service sector. It can also be used in other sectors (industry, agriculture), where there is a demand for low potential energy, which makes it suitable for wide use.

The use of PVT plants has many advantages in increasing the efficiency of buildings, and optimizing energy, since the thermal energy generated by them can be used both for heating sanitary water and for heating homes.

Simulations for the plant were performed with Polysun, but they can also be performed with TRNSYS, as well as with any of the other software in the first group, especially when the study objectives include fluid flow and heat transfer.

In the analyzed schemes, the electricity and thermal energy produced varies depending on the type and demand of the consumer. It also depends on the temperature and the density of solar radiation.

Increasing the utilization rate of solar energy and ambient energy in plants combined with PN, leads to the reduction of GHG (Greenhouse gas) emissions that cause the greenhouse effect.

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# *Designing and implementing an information management system for a non-public educational institution*

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***MSc. Megi DUÇI<sup>1</sup>***

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## **Abstract**

*This paper aims to document all the stages of the development of a management system for a non-public educational institution. Through the use of the latest literature and the qualitative method of data collection, this paper presents each element of the phases of the life cycle of the development of a system, based on the most efficient methodology, carried out concretely to meet the objectives and requirements presented by the selected school. The work's main goal is to design and implement an automated system based on the web, to replace the current system with which the school staff works daily. The reason is related to the problems encountered during the realization of various routine tasks, which are delayed, inefficient, inconvenient, and deficient in functionality. In addition to the loss of time, high possibility of errors, low level of cooperation and marked lack of transparency, manual management of the school process requires a lot of human effort and ongoing monetary costs. To help promote student achievement and success, the institution must have access to complete, accurate, and real-time information. Therefore, the proposed system, passing through the planning phase, the analysis of every data and report collected, the design of the prototype, and the development of the final product, is ready to be implemented in the school, achieving error-free, safe, reliable, and fast procedures.*

***Keywords:*** *system, data management, development cycle, methodology, design, implementation.*

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## Introduction

The education system forms the backbone of any nation and therefore it is important to provide a strong educational foundation to the younger generation to ensure the development of open-minded global citizens. Since education is essential for development, it is considered one of the most powerful instruments in laying a foundation for sustainable economic and social growth. With this aim, our country for years has paid special attention to the education sector and activities for the improvement of relevant institutions, such as schools of different levels, from preschool to high school. To help promote student achievement and success, schools must have access to complete, accurate, and real-time information.

Unfortunately, public and non-public schools in our country still record data through paper-based documentation systems for conducting various studies and generating reports and information that administrators and other employees need to make routine decisions and more. The manual procedures of different tasks take time and may not be completely accurate, since some of the recorded data may be left uncalculated and taken into consideration, as an error on the part of the employee who is manipulating and using them or by the employee who may have performed the initial registration, not in the correct format. In addition to the problem of spending time and the possibility of mistakes, there is also the problem of transparency, since data can be manipulated without leaving a trace in the documents or, due to the lack of correctness on the part of the employees, they are not delegated to the people who should have access in them, such as a parent's knowledge of their child's grades. So, in other words, this manual system is not reliable, besides slow and not at all efficient.

Due to the problems of the current manual system, there is a need to automate it to efficiently handle every registration, update, and deletion of data, generate complete and fast transcripts and reports that satisfy the users and realize continuous communication, transparency in processes, and continuity in periodic updates. The motive for the realization of this work arose from the current situation of educational institutions. The desire to implement my knowledge in the field of development, to help improve management and coordination in schools such as the high school where I completed my secondary studies, prompted me to work on the design and construction of a computer-based management system.

The general and main objective of the project is the design and implementation of a web-based computer system for data management of "Preka College", to move from the traditional manual system to an automated one, significantly improving the process of data storage and data manipulation of this institution. To achieve the general objective, I aim to achieve these specific objectives:

- To record data accurately to increase transparency and efficiency throughout the necessary processes, thus reaching a management system without errors, that is safe, reliable, and fast.
- To create a large volume grouping with real and current data of the institution.
- To carry out quality communication with the database to generate reports in real-time and with high authenticity thus helping in the decision-making process.
- To build a specific profile for the role of the system administrator with full access rights, as well as a profile for students, teachers, and parents, with more limited access rights.
- Successfully carry out all the tasks and communications that will be assigned to each of the profiles by the real relationships outside the system, to emphasize once again the collaborative environment.
- Follow the activities of students and teachers through updates related to timetables, grades, exams, payments, announcements, or direct messages.

## Literature Review

### *Manual system and automated one*

Studies conducted (Leithwood, Patten, & Jantzi, 2010) on school effectiveness reveal that there is a long list of factors that determine its success. Marzano (2002) indicates that these factors are generally grouped into five categories, which are: guaranteed and applicable curriculum, challenging goals and effective feedback, parental and community involvement, safe and orderly environment, cooperation and professionalism of the staff (Tsereteli et al., 2011). Today, during the age we call the information age, the biggest risk an organization or institution can take is to remain “insensitive” to change. Many important factors such as continuous developments in information technologies, information exchange, growing expectations of society, perceptions, and modern management applications make organizations around the world develop new applications to survive (Shema, 2019). Public and non-public schools of primary and secondary education seem to need such applications now more than ever because every year they are faced with a very large number of data, the registration, manipulation, and transfer of which seems to take time and increases the potential for error if done through manual, paper-based systems.

To manage schools effectively and efficiently, some problems arise related to manual systems that are still practiced today in schools of different levels in our country. (Jacksi, Ibrahim, and Ali, 2018) discuss some fundamental problems



related to the manual school system in developing countries such as document loss, stating that 7.5% of all documents are lost and 3% of the rest are filed mistakes. This proves that out of every thousand documents, twenty of them remain in the wrong place, while most of the lost documents can no longer be produced. This greatly increases the risks and costs associated with a manual school management system.

On the other hand, (Shema, 2019) says that the manual management of the school process requires a lot of human effort and waste of time, considering that the administrators have to enter the information of the students every time they want to register for the new semester making the data to be duplicated. Disadvantages of the manual school system also include difficulties in accessing real transcripts, which represent the transparent part of generating results or other information. This means that if a student's academic results are required, the opportunities to manipulate the data based on bribes are not as high as submitting them manually on paper.

Since the benefits of computer use in terms of efficiency have led to the widespread use of computer technology for operation and management activities (Shema, 2019), it seems that the creation of an automatic management system for the data needed in these schools is necessary. School Management Systems have been described in the literature as a possible lever in increasing school management performance. Demir (2006) asserts that school management boards that collect, analyze, and use information about their institution make better decisions not only for improvement but also for institutionalizing systemic improvements. These systems have changed school management in the areas of leadership, decision-making, workload, human resource management, communication, responsibility, and planning. A School Management System allows users to store almost all school information electronically, including student information, teacher materials, absences, announcements, etc. Most importantly, this information can only be shared with authorized users, the report can be easily generated and the records can be easily searched, reported, and printed.

A well-designed automated School Management System ensures that data is readily available to efficiently manage the education system and effectively meet the needs of school management, teachers, parents, and students. A well-designed system offers many other interests, such as cost minimization which is the most obvious and vital benefit of any institution. Other benefits that users will get when using the system are that it will help them carry out their daily activities in an uncomplicated and more effective manner, including easily creating profiles, computerized management of grades and evaluations, easy interaction between teachers, parents, and administrators, easy generation of time tables. Users can also get is a high level of security using the identification and authentication of users



who can access the system after being equipped with a unique profile manageable by the administrator.

To successfully develop any type of legitimate information system, there must be a sequence of processes, procedures, methods, principles, and techniques that the developer must consider (Dennis et al., 2015). This includes the step-by-step process that the developer must follow to successfully develop the system, in other words, the methodology used to control the process. (Shema, 2019) states that a good methodology should cover project management, time, project plan cost, procedures, and rules in developing any system, etc. People rely on Information Systems to communicate with each other using a variety of physical devices, information processing instructions and procedures (software), and stored data (data resources). Therefore, Boell & Cecez-Kecmanovic (2015) describe the information system as an important issue that plays a principal role in facilitating, planning, coordinating, and controlling an organization.

The main type of information systems in various organizations include transaction processing systems, decision support systems, management information systems, and executive support systems. However, to develop any type of computerized system, there is a need to do a detailed analysis of the existing information systems tactics that will be followed to implement successfully the system to be built (Ajobiwe, 2020). Management Information Systems (MIS) and Transaction Processing Systems (TPS) are mostly used in systems that include components such as inputting, storing and processing, receiving and transferring reports (Teka, 2011); moreover, all this has the nature of school management systems, therefore these two are the suggested types of IS to manage the operation of the proposed management system in Albanian public and non-public schools.

The proposed system is categorized as an MIS and a TPS at the same time, so to build a School Management System by completing all the necessary elements, it will be necessary to combine the Transaction Processing System and the Management System Information. MIS is used at the managerial level, more specifically in the case of the school, it is used by the person with the post of administrator and uses data generated by the TPS, which on the other hand includes the daily routine activities carried out at the operational level, in the case in question, the teachers and students. These transactions can be commercial transactions such as periodic billing and also include other processes such as registration, modification, storage, and retrieval of data. So, in conclusion, since both categories improve the effectiveness and productivity of the organization, the institution in our case, the most appropriate information system to use in the implementation of this system is the combination of MIS and TPS.



## 1.2. *Software Development Life Cycle*

Most organizations find it useful to use a standard set of steps, known as a system development methodology, to develop and support their information systems. Like many processes, information systems development often follows a life cycle, known as the Software Development Life Cycle (SDLC). Scholars and researchers describe the system development life cycle as a methodology used to develop, maintain, modify or completely replace existing information systems through the phases of planning, analysis, design, implementation, and maintenance (Gillenson et al., 2011).

To propitiously develop the school management system, it is necessary to choose the right methodology. Gillenson et al. (2011) in their study stated that the choice of the appropriate methodology determines the quality of the system, meets or exceeds the expectations of the end users, and reduces the subsequent costs to be managed and improved. However, the choice of methodology depends on the size and type of project, therefore no methodology is the absolute best; all models have their advantages and disadvantages, and the key is to be flexible and find what works for the organization and end users (Satzinger et al., 2015). In this section, the selection of the appropriate development will be carried out as well as the reasoning why, just as in the case of the selection of the information system. Let us first deal with the SDLC phases, which are presented in the diagram below:

### **i. Phase 1: System planning and selection**

Planning is the basic process of understanding why an information system should be built and determining how the project will go, identifying the need for a new or improved information system if the system is successfully developed, what benefits it will bring end users, and what are the problems that the system will have solved after development (Dennis et al., 2015).

### **ii. Phase 2: System analysis**

Before developing any type of software system, it must be identified what the system will do, what the system requirements are, who are the users that will be using the system, and when and where the system will be used. First, the analyst interacts with users to determine what they want from a proposed system, then the collected requirements are studied and structured according to their relationships, eliminating any repetition.

### **iii. Phase 3: System design**

During systems design, analysts convert the description of the recommended

alternative solution into logical and then physical specifications of the system. In other words, the design phase decides how the system will work, in terms of hardware, software, network infrastructure, user interface, forms and reports, specific programs, databases, and files that will be needed.

#### *iv. Phase 4: System implementation and utilization*

The previous system specifications are turned into a functional system that is tested and then put into use, including processes such as coding, testing, and installation. The implementation phase is usually the most critical because it is the moment when design turns into coding. The processes continue with installing the system, loading the new system with data, testing the functionalities, and training the customers.

### *System Development Methodologies*

According to (Stanisevic et al., 2011) the choice of methodology is not easy because no methodology is always the absolute best. However, based on the characteristics of each of the methodologies, an ideal one can be selected even in the case of a school management system. We can achieve a result if we make a comparison between the methodologies used in different situations based on these criteria: the user's ambiguous requirement, which emphasizes the team's ability to adapt to the situation when the user does not know how the system should be or what his system should do; the ability to adapt to a new technology that cannot be used by users; the complexity of the system; reliability; the user's estimated time for the final project; visibility from iterated parties and finally documentation along the way.

After evaluating the previous criteria throughout a development project, it seems that the throwaway prototype methodology is the most appropriate one to develop the new management system proposed in this paper. With the help of the selected methodology and the cooperation of all interested parties, the existing system will be analyzed, later to design and build the prototype of the system, which the users will evaluate and give corrective feedback, thus understanding what the system can do. According to (Sami, n.d.) throwaway prototyping methodologies are excellent choices when timelines are short, which once again emphasizes that development through "throwaway" prototypes is the most appropriate to follow in this case study.



## Planning and Analysis

### *Methodology and research methods*

In conducting any type of research, the researchers must understand the particular problem they aim to solve; this will help them understand the various important areas of research evaluated. Therefore, through this chapter, I intend to highlight the real problems of the current manual system that “Preka College” continues to use in its daily life and the expectations of end users towards the new digital system. To proceed with the phases of this cycle, it is first necessary to carry out research. This is an organized investigation that uses conventional scientific methodology to solve problems and create new knowledge that is generally appropriate, to create and achieve new conditions (Goundar, 2012).

Given the purpose of this paper and the data it needs, this research will focus entirely on qualitative research, which is described as collecting, analyzing, and interpreting data by observing what people do and say; to discover meaning, and feel and giving a broad description of the exact situation. It is necessary, to help the college under study, to know more about the problems of the current system and how it can be changed to be more user-friendly. The best way to collect the data needed would be to interview the administrator and the head of “Preka College”. For years now, most of these schools have made it part of their regulations to keep up-to-date with the opinions and suggestions that come from these external factors periodically, so the school leaders are aware of the problems and needs of the students, their parents, and employees as well. This justifies the reason why part of this study will be an interview with the two persons responsible for the administrative and managerial parts of the school. Two main things are intended to be achieved through the interview: pointing out the problems that require solutions and suggestions from the interviewed staff regarding those requirements that they have and want to see implemented in the system that will be developed.

### *Planning*

To create an information system, it is necessary to build a plan on how the development will be carried out from the beginning to the last stages. Therefore, the same will be applied in the development of the proposed management system of the College, as a sequence of procedures or methods must be carried out for the development to be completed successfully. During the planning phase, the institution or business identifies the need for a new or improved system. Oftentimes,

it happens that the customers for whom the system is made, do not have clear ideas of what problems are expected to be solved, as they initially have problems with their identification. The answers to why the system needs to be built and it will benefit the end users will only be obtained through interviewing the Administrator and Headmaster because internal employees are the only ones who can properly address problems that may seem trivial.

Initially, the first step is to formulate the questions and structure the interview so that they are simple and understandable for the interviewees, taking into account the avoidance of technical words related to the stages of system development or other technological elements, on which the administration has no reason to know, thus complicating the interview procedure. Also, these questions should give the possibility of receiving clear and complete answers, enough to enable the extraction or translation of the answers into direct and real requests. Building and conducting the interview is one part of this stage, but the most challenging part is when it comes to analyzing the answers of the two people being interviewed, with the sole purpose of listing the problems, and requirements and creating specific objectives that are expected to be met stage after stage. Not having knowledge directly related to this field, the interviewees can look for options that a system developed under these conditions would never have the opportunity to fill. Human, time, and financial resources should always be taken into account if there is a possibility that the request will have a logical and practical application.

### *Analysis*

During this phase, it is essential to do a proper study of all the needs presented by the school, its staff, and third parties, problems, and requirements, which we can group according to users or system elements. If through the analysis of the responses from the interview it is possible to identify opportunities and areas for improvement, then a concept for the new system can be easily developed, and by understanding where these requirements come from, we can specify who are the users who will interact with the proposed system. According to the representatives of “Preka College”, the problems with the manual system start from the moment the students are registered in the school, a procedure that takes time and is not efficient at all. The only person who had full rights over the system was the secretary of the institution, this means the problem with transparency was identified. Requests for data views, changes, copies, and everything else go to that employee, which also creates unpleasant and unnecessary delays, which is pointed out not only by the academic staff but also parents of students. Also, academic staff and students needed a space where they could access additional learning information and communicate more easily about academic progress, through grades or comments.



Regarding the question of how parents were informed about grades or other daily academic progress of students, the interviewees answered by saying that everything was left to the children's sincerity. The cause of other problems for managers is seen to be the authorization of a single person to throw, update, delete, and verify various data. In the case of setting a wrong grade by the subject teacher, this mistake continues to be transferred to the documents managed by the secretariat. Other changes, deletions through any method or other means, are categorically prohibited according to the explanations given by the interviewees. Analyzing the problems that the administrator and headmaster of the College presented during the interview process, serves us to present some concrete and clear requirements that this private institution wants to be met by the proposed new system.

- To increase transparency and give different individuals the opportunity to access data that is part of their responsibilities, the new system will be structured in several panels, administrator, teacher, parent, and student, each with different access rights depending on tasks and functionalities.
- Official school announcements can be made in the system and can be seen by all user panels, so each system actor will have a space dedicated to announcements in the menu.
- Each invoice can be printed, and serve as a payment mandate, a form of proof for the parties who participated in the action.
- Students' attendance is recorded according to the calendar days, avoiding the storage of countless sheets that make a daily check of students' absences. The system must enable such a storage format to return reports and data for any date that may be requested.

Establishing security in the system is a very important thing to consider, so the proposed system should have the ability to prevent unauthorized users from accessing it to maintain data confidentiality. Although Preka College has specific working hours and days, the proposed system will be accessible by administrators, teachers, parents, and students at any time, 24 hours a day, seven days a week. The system interface should be user-friendly to be easy enough to use and understand.

## **Design**

### *Requirements specifications*

With the explanation of the functionalities and requirements of the system in the previous chapter, now the functionalities will be described not simply listed but

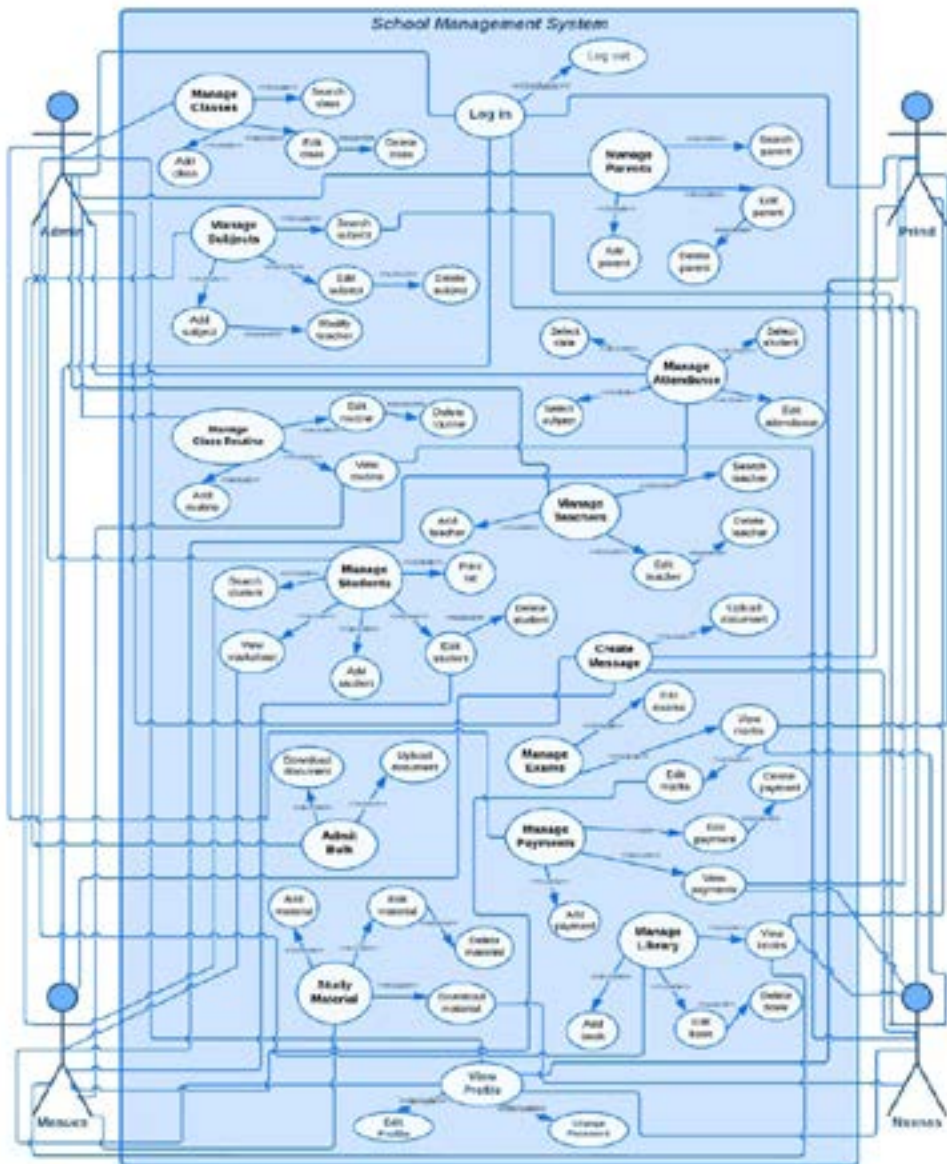
specified concerning the processing mode. Below are presented in general lines some elements that are listed to be designed in the future.

1. *Login/Logout*: Enables users to log into the system using their user email and password; logout serves to exit the system.
2. *Forgot password*: If users happen to have forgotten their password, they are allowed to retrieve their password via an email message.
3. *Add/Edit/Delete*: Users such as administrators or teachers will have the opportunity to add, edit and delete data, within the level of access they have.
4. *Download/Upload document*: Students will be able to download study materials placed on the system by their teachers. Also, through this function, the student data recorded by the secretary can be easily uploaded.
5. *Send message*: Essential element for ease of communication, increased collaboration, and reduced time, available for all user dashboards.
6. *Print document*: Some documents need the option to be printed for transparency and two-sided correctness, for example, financial invoices.

### *Use Case Diagram*

Use Case diagrams are functional diagrams that describe the basic functions of the system, showing what users can do and how the system can respond to their actions. Each graphical element in the Use Case diagram describes one and only one function through which users interact with the system, although users may take several paths to interact with it.

- *TEACHER → MANAGE MARKS*
  1. The teacher clicks Manage Marks.
  2. The system activates the grade management page.
  3. The teacher selects the given exam.
  4. Select the assigned class.
  5. Select the assigned subject.
  6. The teacher presses the Manage Marks button.
  7. The system displays grades according to verifications related to the above definitions.
  8. The teacher changes the grade and comments for the student he wants.
  9. Press the Update button.
  10. The system makes the requested change and displays it.
  11. The system displays the success message.



*Exceptional cases*

The system does not allow the selection of the subject, without first selecting the class. Then you can proceed with the display of grades.



## ERD

An entity relationship diagram is a data modeling technique that creates a graphical representation of the entities and the relationships between them within an information system. To move on to the construction of this diagram, it is essential to devise the tables where the data will be stored, therefore below are listed the entities of the school system and the corresponding attributes, where primary keys are highlighted in blue, while foreign keys are highlighted in green.

1. admin – (admin\_id, name, email, password, level)
2. student – (student\_id, name, birthday, sex, id\_no, blood\_group, address, phone, email, password, father\_name, mother\_name, class\_id, section\_id, parent\_id)
3. teacher – (teacher\_id, name, birthday, sex, id\_no, blood\_group, address, phone, email, password)
4. parent – (parent\_id, name, email, password, phone, address, profession)
5. class – (class\_id, name, numeric\_name, teacher\_id)
6. section – (section\_id, name, nickname, class\_id, teacher\_id)
7. class\_routine – (class\_routine\_id, class\_id, subject\_id, time\_start, time\_end, day)
8. subject – (subject\_id, name, class\_id, teacher\_id)
9. grade – (grade\_id, name, grade\_point, mark\_from, mark\_upto, comment)
10. acd\_session (session\_id, name, is\_open, start\_dt, end\_dt)
11. attendance – (attendance\_id, status, student\_id, date)
12. book – (book\_id, title, author, description, class\_id, status, price)
13. ci\_sessions - (id, ip\_address, timestamp, date)
14. document – (document\_id, title, description, file\_name, file\_type, class\_id, teacher\_id, timestamp)
15. exam – (exam\_id, name, date, comment)
16. expense\_category – (category\_id, name)
17. invoice – (invoice\_id, student\_id, title, description, amount, amount\_paid, due, creation\_timestamp, payment\_timestamp, payment\_method, payment\_details, status)
18. mark – (mark\_id, student\_id, subject\_id, exam\_id, mark\_obtained, mark\_total, comment)
19. message – (message\_id, thread\_id, message, sender, timestamp, status)
20. message\_thread – (thread\_id, thread\_code, sender, receiver, last\_message\_timestamp)
21. noticeboard – (notice\_id, notice\_title, notice, date, create\_timestamp)



22. payment – (payment\_id, category\_id, title, payment\_type, invoice\_id, student\_id, method, description, amount, timestamp)
23. settings – (setting\_id, type, description)
24. transport – (transport\_id, route\_name, no\_of\_vehicle, description, route\_fee)

## Implementation and testing

### *Development Tools*

Based on the literature and other studies that are not included in this paper, programming languages, libraries, different frameworks, data management systems or other elements related to the development of the system and its deployment are endless and each with specific characteristics and attributes, resulting in none being the best possible solution for every possible case. In the following parts, the tools and the reasons why they were chosen to be used in the construction of the Preka College system are specifically addressed.

The environment selected for the development of the Preka school system is Visual Studio Code because it is open source, user-friendly, and has extensions that significantly facilitate the work during coding. The main language selected for the development of the proposed system is PHP. It is known as a server-side scripting language that is used for many purposes, but that serves mostly for web developments, making them dynamic and interactive. Being a web-based system, in this paper PHP is incorporated with HTML, CSS, and JS. To make the system easy to navigate and aesthetically attractive, this paper it was chosen to use the CSS framework, Bootstrap. Having a time limit for the design and construction of the concrete system has increased the need for the use of this framework, which manages to help the development process of the front-end nature. In addition to Bootstrap, another framework that has been used in this work is the PHP framework, CodeIgniter. CodeIgniter provides “out of the box” libraries to connect to the database and perform various operations such as sending emails, uploading files, managing sessions, etc.

In addition to the tools that are needed for the development of the system, the tools that serve for the creation of the database and their management should also be mentioned. The first tool used is the Xampp platform, which helps a local host or server to test the website before releasing it to the main server. It is a platform that provides a convenient environment to test and verify the operation of projects based on Apache, Perl, MySQL Database, and PHP through the host system itself. Consequently, based on the fact that the work is done with PHP, it seems like the

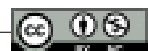
best alternative. To move on to other tools, the selected web server, which is also supported by Xampp, is Apache, while MariaDB will serve as a database server or as a database management system. Based on the studied literature, MySQL turned out to be a very good and advisable system, but in the case of the proposed system, MariaDB manages to meet the expectations and requirements presented. To create, manage, and update the data, phpMyAdmin will be used, as an open-source software tool, written in PHP and intended to handle the administration of DBMS such as MySQL or MariaDB on the web.

For the development of this system, a three-tier architecture was used, the main benefit of which is the separation of logical and physical functionalities. To make it more concrete I will explain the development technologies used for each architecture level:

- Web Server Tier or otherwise presentation tier (presentation level) represents that part of the system that the user sees. This layer is built using Bootstrap and communicates with other layers through API (Application Program Interface).
- Application Server Tier is otherwise referred to as the logical tier. This level is written in the PHP programming language, which supports the main functions of the system. At this level, modifications can be made by adding or removing users without having to update the database.
- Database Server Tier or the data level is represented by MariaDB as a server and by the management system for read/write access PHPMyAdmin.

### *Testing of the system*

After developing a system, the next thing that is done by the programmers is to verify, validate and control the application, as well as to detect defects and errors that need to be given more attention. This stage is part of the implementation stage and is called testing. Testing is performed to ensure that the system meets business requirements and technical procedures and to ensure that it functions perfectly. Testing of the Kolegji Preka management system will be carried out at this stage of development to detect unnecessary errors before it is presented as a finished system to end users. In fact, the testing phase does not start and end with control performed by the working group. The latter is based heavily on the feedback and opinions that users create during the period they use the system. This helps the team to continuously improve and update the system, always if this is part of the agreement between the developer business and the requesting client. An example would be testing whether anyone can become part of the system, or whether previously imposed restrictions work. If a user tries to enter the system without



filling in the credentials fields, after clicking the Login button, the system turns the frames of the textboxes red and displays the note “This field is required.” In case the user sets his credentials incorrectly, or his profile does not exist and presses the Login button, the system after the verifications displays the message “Invalid Login” and asks the user to enter the correct data.

## Conclusion

This work was carried out to document the work and processes of building a Management System for the non-public High School, Kolegji Preka, which submitted the request for the replacement of the current manual system used by their academic staff, with an automated and easily accessible one. The work has been divided into stages according to the phases of the systems development life cycle, therefore it started with the planning of the work processes and ended with the implementation phase. Initially, a detailed study of the existing literature was carried out, comparisons were made between different information systems, to conclude that this system will serve as an MIS and TPS at the same time. In addition to this comparison, several others were made about system development methodologies, where “Throwaway Prototyping Development Methodology” was more efficient. After clarifying these details, the paper continues with the concrete and practical side of the SDLC phases.

The first action during the planning phase consisted of communication with the leaders of Preka College through a physical interview, intending to collect as much data as possible related to the progress and continuity of daily life of the current system. The interview is considered a “fact-finding” technique, which serves to clarify the situation as much as possible and to avoid later problems if the requirements and objectives are not set properly. During this phase, it was clarified that the school’s resources will be used for the construction of the new system and not for the improvement of the existing one.

Conducting the interview and collecting complete data opened the way to the analysis phase, which consisted of studying the interview to list concrete, clear and realistic objectives and requirements for the system. The result included requirements related to building panels for different users, who should have different levels of accessibility; having a way of logging into the system that protects the data, but also allows different users to access the data that is part of their responsibility, such as students checking their grades after different tests; increasing transparency and speed of data collection or processing; facilitating processes related to payments or obligations that different individuals have towards the school; storing data quickly and managing it quickly and accurately. Also, the

system was required to be reliable, available, easy to use, simple to understand, and secure.

Following the development stages, during the design all the information that was collected using the aforementioned techniques was presented and organized in the form of a Use Case Diagram, Entity Relationship Diagram showing the entities and the relationships between them. All this modeling enabled a clear picture of how the proposed system would work, which managed to help Preka College leaders and staff better understand the prototype.

After the executives approved the prototype, it was time for the implementation phase to start. During this phase, after the selection of tools for development and implementation, the appearance, content, and functionalities of the system were coded. The database was created and the connections between tables and functions were built in the code, with a change from what was specified in the literature review phase (starting work with MariaDB), making each element of the system fully capable of performing the tasks to which was originally designed. The implementation phase cannot be completed without conducting tests to see the quality and functionalities of the system. This stage continues even after the system is put into operation, as opinions and feedback are expected from users regarding the progress and quality of the work processes.

Finally, with the completion of the stages of the systems development life cycle, the work has been completed. The quality of the system can be improved, always based on the documentation that is built based on the reports that are created with the help of the data from the users and based on the developments of the latest technologies that facilitate many procedures and make the system easier and more comfortable to use. At the end of this paper, it is noted that all the initial objectives presented in the introduction have been fulfilled, thus completing the biggest and most important objective which was the design and implementation of a quality system, fully functional for Preka College, according to its requirements and needs as a customer.

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# *Some model driven software development approaches*

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## **Abstract**

*A model is a simplification of a reality, an abstraction, which neglects all of the irrelevant aspects of a software and focuses on the ones which define the software. Through modeling, we can visualize the software in a way which is understandable from both computers and people. Unified Modeling Language (UML) is a language, which stands in a higher level of abstraction than any programming language and through it, we can build software models from the simplest to the most complicated ones. However, even though through UML we are able to design software's and to generate a considerable amount of code, still we need to write tons of lines of code in a certain object – oriented language. In order to be totally independent from the execution environment and to focus entirely in business logic as what really defines a software we need to go further. To achieve this goal, the executable UML and state machines concept is introduced. "An executable UML model is one with a behavioral specification detailed enough that it can effectively be run as a program" (Seidewitz, 2011). Through executable model a higher programmer productivity could be achieved and the system is not affected by the year after year change in development technologies, which require that the system to be upgraded each time there are changes in run-time environments. On the other hand, through state machines we are able to simulate the execution of a program through the model. Thus we can develop information systems using*

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*techniques which stand in a higher level of abstraction and platform independent that can be translated in whichever specific platform of implementation.*

**Key words:** *model driven development, software, state machines, executable UML*

## **The introduction**

In the brief history of information systems, besides different approaches regarding the analysis and development of these systems, we can all agree that the progress in the field has been tremendous. All this innovation has been driven by the continuous growing demand for systems which manage, save and handle the massive data which are generated from our daily life activities. In order to develop systems which, meet the user requirements effectively it is important for the system to be specified correctly. A way to achieve this goal has been proven to be software modeling. The model is a simplification of reality, which helps us have a better understanding of our software. It serves as a blueprint for the further stages of the software development. The most accurate tool regarding modeling is the Unified Modeling Language. UML provides a modeling language which is understandable from both humans and machines. Because the model it is organized visually in diagrams and a considerable amount of code is generated directly from the model.

However, the model specifies the software from a static point of view and it is still necessary to translate the model in a specific implementation platform to represent the detailed behavior of our system. In order to escape this bottle-neck the new executable UML it's introduced. "An executable UML model is one with a behavioral specification detailed enough that it can effectively be run as a program" (Seidewitz, 2011). Another solution which supports expressing detailed behavior in a model is the concept of state machines. In this paper, through the theoretical analysis, but also through practical examples, the standard of the executable UML and state machines will be explored.

### *Aims*

This paper aims to represent the advantages that model driven development offers in the software development industry. Thesis aims to:

- a) To argue the way which executable model improves software development processes.
- b) To represent through concrete examples the benefits of software development in a higher level of abstraction.



- c) To argue how the model-based development increases programmers' productivity in a dynamic software development market.
- d) To reason how model driven development offers a link between business requirements and programming languages.

## *Objectives*

This paper objectives are:

1. Building two software prototypes based on a visual model which is easily readable, modifiable and reusable using executable UML and state machines technologies.
2. To emphasize the aspects in which developer's productivity is improved through all the stages of software development life cycle.
3. Developing an information system which is totally independent from programming languages and translatable in each object - oriented programming language.
4. To provide a documentation for the system which will be developed that resists throughout time.

## **Analysis**

### *Model Driven Architecture*

As the name suggests, in the model driven architecture in the main scope of development process; it is the model. On the contrary from model driven architecture, the traditional software development passes through several stages such as functional requirements analysis, feasibility analysis, design, coding, testing and development. This process besides long, can be stressful and requires a lot of working hours. The reason for this it is because it is necessary a journey from the high level of functional requirements analysis to the technical low level of abstraction, which is coding. "Models are the stepping stones on the path between a description of a business need and the deployable runtime components of its solution." (Brown, Iyengar, & Johnston, 2006). "Within MDA the software development process is driven by the activity of modeling your software system" (Kleppe, Warmer, & Bast, 2003).



## *The benefits of model driven architecture*

Taking into consideration the commercial success of programming languages and frameworks based on them, it is fair for one to think, which are the benefits of model driven architecture? In this type of architecture, we have two main benefits, which are productivity and portability. This approach is more productive since a model which is independent from the implementation platform avoids the development technicalities embeded in a specific platform and it is focused on developing solutions for business requirements. The other benefit, portability makes it possible that a system based on the platform independent model to be translated in every platform specific model. Furthermore, the translation into a PSM, it is much faster and feasible, since a considerable amount of code it is generated automatically from the platform independent model. “The main idea in MDA it is building detailed enough models and to use transformations to generate the most part of the code” (Starr, 2002).

## *Model Driven Development*

Model driven development includes several processes, which start from creating a model to delivering an executable code. “MDD is primarily concerned with reducing the gap between problem and software implementation domains through the use of technologies that support systematic transformation of problem-level abstractions to software implementations.” (France & Rumpe, 2007). According to this approach, model driven development is a series of transformations, which have as an input a model and as an output another more detailed model, until the software implementation is achieved. For example, if we want to design a software, firstly we have to define the objects which will be part of the model and also, we have to define the state and behavior of these objects. Furthermore, model after model, the state and behavior of the object becomes more and more detailed, to the point which the information system it is completely developed based on the model. “The benefits of adopting MDD include reduced software development time, enhanced code quality, and improved code maintenance.” (Chao, et al., 2006). On the other hand, another important aspect of the model driven software development approach, it is the process of model driven software testing. “Model Driven Testing is an approach based on MDD in which tests can be generated from development models in an automated way through the use of transformations” (Baker, Rai, Grabowski, Haugen, & Williams, 2008). Imagine a software development process, which goes through all the stages of software development life cycle. The modeling process it is right after functional requirements analysis, meanwhile testing

according to the traditional method of testing is a step before deployment. If it is the case that in testing serious issues are identified regarding business logic of the information system, there would be unimaginable consequences of wasted working hours and resources. MDT approach mitigates this problem by testing the software based on the model, which is developed.

### *Executable UML*

In the model driven architecture there are two main behavior modeling approaches. One of these is elaborationist approach, which uses formal languages to manage the definition of object's behavior.

“The second approach is referred to as translationist; the complete system should be defined within the PIM.” (Papajorgji & Pardalos, 2016). “In the elaborationist approach, the definition of the application is built up gradually as you progress through from PIM to PSM to Code.” (McNeile, 2003). In order to make this work “in 2008, this led to the adoption of the Foundational UML (fUML) specification, providing the first precise operational and base semantics for a subset of UML encompassing most object-oriented and activity modeling” (Seidewitz, 2011). However, this was still not enough to support full specification of object's behavior in an UML diagram. To properly define the methods through which objects would operate and implement their behavior, you would have to draw detailed activity diagrams, which take a lot of time and effort and they are not effective. So, it became necessary to apply a language for objects interaction and this language was Action Language for fUML or Alf.

“Alf is basically a textual notation for UML behaviors that can be attached to a UML model any place that a UML behavior can be. For example, Alf text can be used directly to specify the behaviors of a state on a state machine, the method of an operation or the classifier behavior of an active class. Further, the “extended” Alf notation actually includes some basic structural modeling constructs, so it is also possible to do entire models textually in Alf” (Seidewitz, 2011).

Since, semantically Alf marks a subset of fUML, the last one could be interpreted as an execution environment for Alf. “The goal is to make UML modeling executable modeling, to allow designers to test and verify early and to generate 100% of the code if desired.” (Sunye, Pennaneac'h, Ho, Guennec, & Jezequel, 2001). “Indeed, the real power of executable modeling going forward relies on keeping the entire behavioral specification at such a higher level of abstraction.” (Seidewitz, 2011).



## State machines

According to object-oriented paradigm, an object is characterized from two significant components, which are state and behavior. To bring in memory, state is one of the many situations in which an object might find itself, as for behavior it represents how an object behaves and reacts to other objects requests. So, we could say that the state of an object is a static view of an object defined at a certain moment, meanwhile the behavior includes all the dynamics, which affect the state of the object or which the object affects other object's state. But how the change of these states happens, which are the situations which trigger the process of changing the state of an object? To get an answer we need to include the concept of state machines. "A state machine is a behavior that specifies the sequences of states an object goes through during its lifetime in response to events, together with its responses to those events." (Booch, Rumbaugh, & Jacobson, 1999). Events which trigger the change of a state might include signals, method calls or time passage. Depending from the happening of the events, an activity will be triggered, which will affect the actual state of the object. Activity represents an action, which impacts the state of an object.

## Simulation

### Executable UML prototype

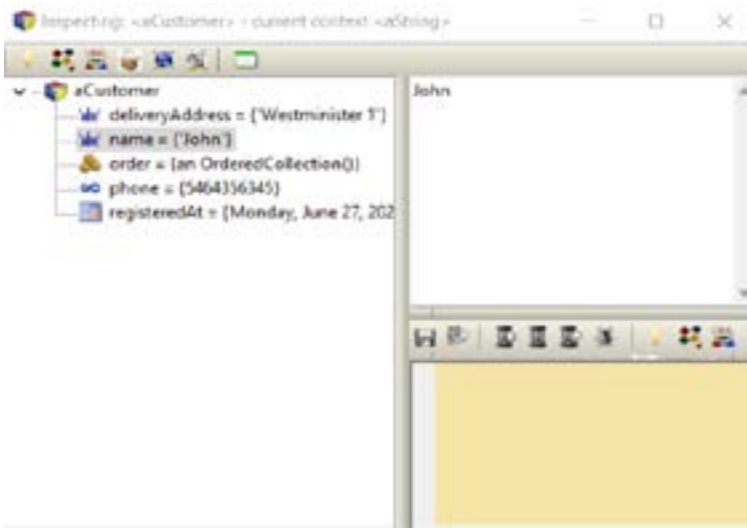
In order to create a better understanding of the executable UML standard, I will be demonstrating an executable UML diagram. This example will represent an e-commerce executable class diagram as it is shown below:

**FIGURE 1.** Class Diagram of E-commerce system



After the design of the class diagram for the e-commerce system, next we will execute the model in the UML Almighty environment. UML Almighty is a runtime environment specialized for the UML executable standard. In order to run the program, we have to define a class which will serve as a reference for the executable UML prototype. In this study case, since the center of activity is the Customer class, will serve as a reference to execute the application. In the picture below, it is displayed the initialization of Customer class:

**FIGURE 2.** Customer class instance



Using the powerful abilities of simulation in the UML Almighty, it is possible that right after we design the model, to be able to create class instances. All this, without having to select as PSM environment and without entering in technical details of a specific development platform. The standard of executable UML provides us with a prototype if the e-commerce system, in which we can test the dynamic aspect of UML model. This ability is quite beneficial because “studies show that modelers, often create models that do not quite reflect how the system will behave” (Farah & Lethbridge, 2007).

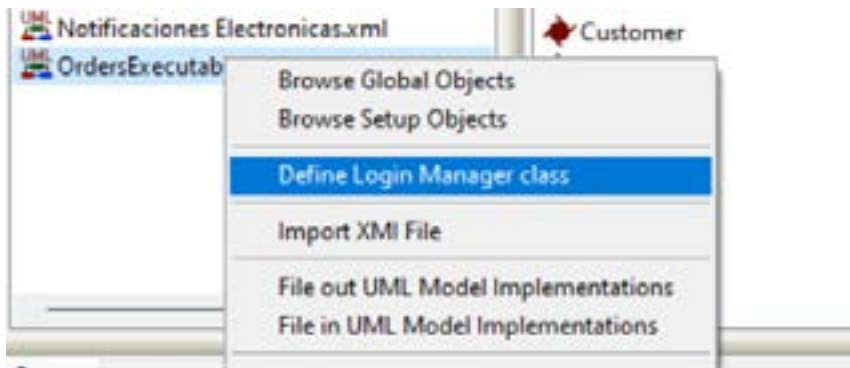
However, as it is known, the class diagram’s goal is to address the static point of view of a system. So, how can we address the dynamic aspect of our e-commerce system, keeping in mind that UML diagrams are not detailed enough to define behaviors and operations which characterize objects. In order to make this happen, we will be using an action language which does the detailed specification of operations.

Customer := Customer newInstance.  
Customer initialize.  
Customer name : 'John'.  
Customer deliveryAddress : 'Westminister 1'.  
Customer phone : '464356345'.  
Customer registeredAt : '27/06/2022'.

Action Language for UML Almighty it is similar to pseudocode and it is high level language close to the human logic.

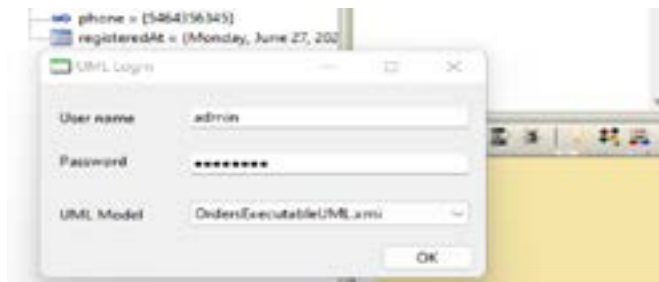
After the creation of a client, the next step into the execution of the e-commerce system prototype it is the login. In order to login, we have to define a class, which will serve as a login manager, much or less like the class which contains the public static void main() method in object-oriented languages such as Java or C++.

**FIGURE 3.** Defining login manager class



Customer class will serve as a main class to our system and now we are ready to test the client's account created earlier. UML Almighty provides two options for the executable UML prototype, one is web based and the other desktop based. In this study, it is used the desktop prototype, in which the user through his account will be able to login, choose products, create orders and make payments.

**FIGURE 4.** Login



After the login, the customer data will appear in the profile:

**FIGURE 5.** Client profile



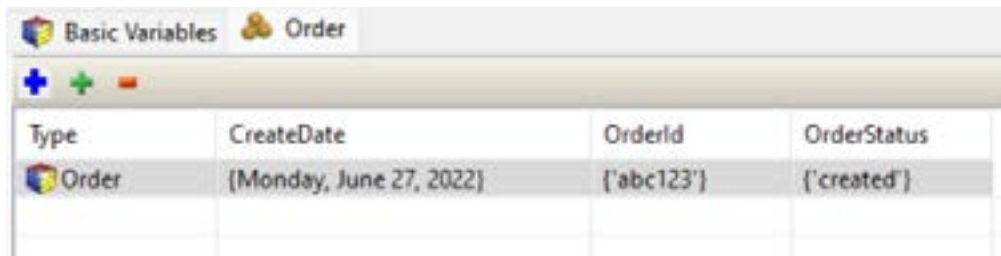
The screenshot shows a software interface with a table displaying client profile data. The table has five columns: Type, DeliveryAddress, Name, Phone, and RegisteredAt. The data row shows a Customer with DeliveryAddress '(Westminster 1)', Name '(John)', Phone '(5464356345)', and RegisteredAt '(Monday, June 27, 2022)'. Above the table, there are browser tabs for 'Login', 'Inspecting: <Customer>', 'Inspecting: <Order>', and 'Inspecting: <Customer>'.

Type	DeliveryAddress	Name	Phone	RegisteredAt
Customer	(Westminster 1)	(John)	(5464356345)	(Monday, June 27, 2022)

The client, in this menu has the possibility to revise his data like name, address, phone number and registered date. The number of data attributes which could be saved for a client is limitless, however for the sake of this simulation only the most essential data are saved. Also, the client can change his data at anytime.

Another functionality of the e-commerce system is adding orders. This feature is set in the Order menu as shown below:

**FIGURA 6.** Orders



The screenshot shows a software interface with a table displaying order data. The table has four columns: Type, CreateDate, OrderId, and OrderStatus. The data row shows an Order with CreateDate '(Monday, June 27, 2022)', OrderId '['abc123'', and OrderStatus '['created''. Above the table, there are tabs for 'Basic Variables' and 'Order'.

Type	CreateDate	OrderId	OrderStatus
Order	(Monday, June 27, 2022)	['abc123']	['created']

The Order menu displays the data like id, status, creation date, to create orders the script below it is used:

```
Order : = Order newInstance.
```

```
Order initialize.
```

```
Order OrderId : 'abc123'.
```

```
Order OrderStatus : 'created'.
```

```
Order CreateDate : '27/06/2022'.
```

Customer class has a 1 x N relationship with Order class, thus an instance of Customer class, a client has a collection of objects or instances of Order class. In order to create the relationship between the client and his order we have to use the action language as below:

```
Customer add : Order.
```

After the order is created, we add products into the order. Products are instances of Item class and hold the necessary information for each product in the e-commerce system. Products are related with orders in a 1 x N relationship, where

in an order we might have many products, while a unique product it is only in an order. In the example, we have the menu which displays the product information:

**FIGURE 7.** Products

Type	Description	Id	Weight
Item	('Cool sunglasses')	('r34r3')	(200)
Item	('Iphone')	('3435')	(300)

This order products store the data for the product id, description, weight. We shall use the script below for adding these products:

Item := Item newInstance.

Item initialize.

Item Id : 'r34r3'

Item Description : 'Cool Sunglasses'

Item Weight : '200'

Item := Item newInstance.

Item initialize.

Item Id : '3435'

Item Description : 'Iphone'

Item Weight : '300'

These product instances shall be added to the order:

Order add : Item.

The other use case to be specified it is the payment process in the e-commerce system. Payments will be executed in the related menu where information regarding payment method, payment id, payment date and amount will be stored. Each payment it is made for a certain order since we specified in the model that the relationship between payment and order it is 1 x 1 and different payment methods are implemented using the polymorphism principle with an interface.

**FIGURE 8.** Payment

Type	Amount	PaymentDate	Paymentid
Payment	(5000)	(Monday, June 27, 2022)	('s44654')

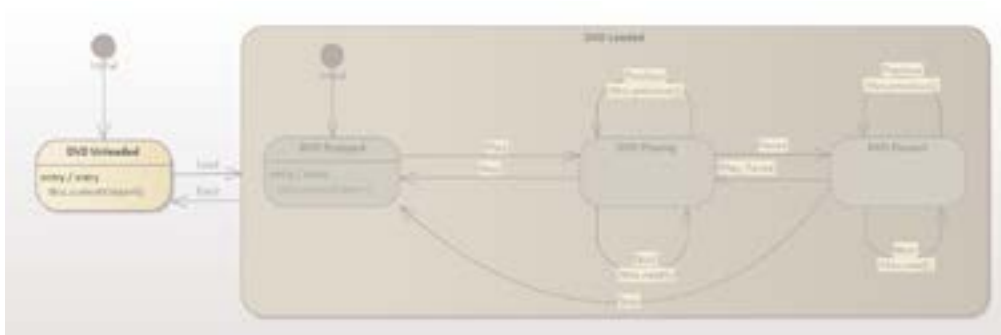


From the UML model execution, we can realize that the model is designed correctly and the information system behavior is according our expectations. E-commerce system simulation was achieved in less time using a low code approach. The simulation through the executable model has the advantage of discovering errors of the solution design since in the beginning and this helps reducing costs which come from an incorrect modeling of the system. In addition, a model driven developed system lets us focus more in the business logic rather than in the specific implementation platform. Coding itself, in whichever programming language it is just a tool which helps us to build software. The key in offering a reliable solution, universal and promising to resist in time it is to focus in the business logic. That is the aim of the executable model, to shift the focus in problem solving and not in the thousand different ways there are to solve them.

### *State machines prototype*

For the state machine prototype, a solution design it is implemented, which will serve as a model for Video Player embedded system.

**FIGURE 9.** State machines simulation



After the design of the state machines model for the Video Player, the model will be transformed into an executable state machine. In the Enterprise Architect's menu, in the Develop tab, button Generate allows us to generate the code for the executable state machine in several object-oriented languages such as C#, C++ or Java. After the code is generated, we select the option start simulation. In the moment that the DVD is Unloaded we could choose the event DVD Load to put the DVD inside the Video Player.

**FIGURE 10.** Begin Simulation



As we can see in the simulation menu at the moment in which we begin the simulation of the state machines, we can track the execution flow and as soon as we start the simulation we transit to the initial state DVD Unloaded. When we click Load, the code generated in Java is responsible for the transit between states process. The logic in the code uses three main concepts in state machines which are states, transitions and signals. The Java code stores an enumeration of all states and transitions which are specified in the diagram and generates a respective method for each transition between the states.

```
private void DVDUnLoaded__TO__DVDLoaded_2221 ( Signal signal,
StateData submachineState ) {
    if ( m_StateMachineImpl == null )
        return;
    if(
        !m_StateMachineImpl.GetStateObject(
submachineState,StateEnum.DVDPlayer_ENUM_STATEMACHINE_
DVDUNLOADED.ordinal() ).IsActiveState()){
        return;
    }
    StateProc(StateEnum.DVDPlayer_ENUM_STATEMACHINE_
DVDUNLOADED, submachineState, StateBehaviorEnum.EXIT, null);
    DVDUnLoaded__TO__DVDLoaded_2221_effect(signal);
    m_StateMachineImpl.currentTransition.SetActive(m_StateMachineImpl);
    StateProc(StateEnum.DVDPlayer_ENUM_STATEMACHINE_
DVDLOADED, submachineState, StateBehaviorEnum.ENTRY, signal,
EntryTypeEnum.DefaultEntry);
}
```

The method above takes as parameters the signal or the event which initiates the transition process and the data of the actual state. If the implementation of the state in a state machine is not initialized, the method does not continue any further with the execution of the transition process. If the actual state of the state machine, it is not active again the execution comes to a halt. If the simulation process passes

those conditions the method calls the actual state and the method which executes the transition process using the signal as a parameter which triggers this process, which in our case it is the Load button. This way the state machine completes a full transition of state from DVD Unloaded to DVD Loaded. So on and so forth, other transitions between states and sub-states continue to happen over and over again through the life cycle of an object.

## Conclusions

### *Conclusions*

Through this paper, secondary sources analysis and simulation through the prototypes of executable UML class diagrams and state machines, it was concluded that:

- Model driven development supports software development in a manner which is fast, accurate and independent from the implementation platform. This development approach shifts the focus from the specific platforms of implementation and emphasizes the business logic as the backbone to provide an efficient software solution.
- Model driven development approach increases the developer's productivity since the model creates a better understanding of the system which is being developed and a considerable amount of code it is generated quickly and accurately directly from the model. Furthermore, information systems which are built according to PIM methodology are universal and portable from the platform point of view. This means that a model driven developed system can be implemented in whatever specific platform which is required.
- The executable UML model supports software testing right after the model is designed, giving the opportunity to verify if the information system behaves as expected since in the early stage of development. This advantage reduces costs, mitigates errors in development and increases the development process efficiency.
- Model driven development creates a precise, whole and understandable documentation of the information system. Because this approach provides us with a model which visualizes in details each functionality of the system, hence offers a valuable documentation.

### *Suggestions*

Taking into consideration the potential and benefits which derive from model driven development, which were evidenced throughout this study and the



simulations of the prototypes of executable UML and state machines, some of the suggestions recommended are:

- Applying model driven development approach as a standard practice in every project which includes software development.
- Researching the usage of editors, which support executable UML and the expansion of their capacities to build and execute models with detailed enough behavior to be ran as a program.
- Developing software which are independent from the implementation platform in a higher level of abstraction from the programming languages of our present. As Booch said, the idea of developing software in C++ or Java, in a near future will sound as absurd as it is nowadays to write an application in assembly.

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