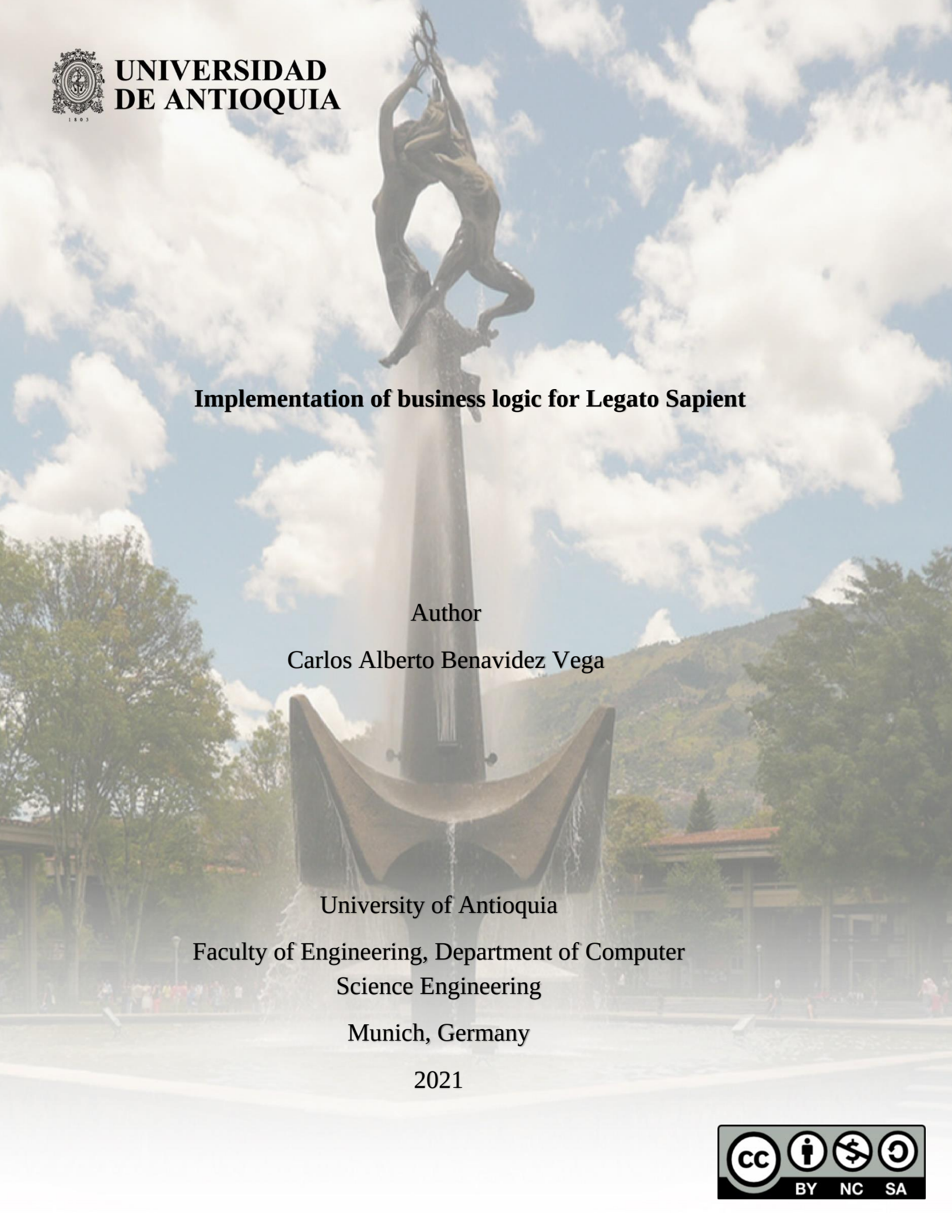

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Implementation of business logic for Legato Sapient

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2021

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Internship Report as Requirement to apply for the degree of

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Content

Summary

This project suggested the need to provide implementations which could be adapted to the customer requirements; Those implementations were based on business logics proposed by the customer. The integration of new business logics into the project contributed that the services provided by ***MES*** (Manufacturing Execution System) ***Legato Sapient*** could be adapted to the customer needs in a better way.

In addition to the above, it was required to evaluate the new releases of Legato Sapient to detect bugs, ensuring that the bugs levels could remain as low as possible during the execution in the production environments.

To cover those aspects, it was proposed within the framework of this project, perform the following activities which could help to fulfill the needs stated.

The activities were:

- Implementations (Custom Scripts)
- Development with Ember
- Parameterization
- Testing
- Documentation

The implementations within the project ware divided into two sections, the first of them was the development of custom scripts, the purposes of these scrips sought an optimal way to extend existing functionalities, which have been created by core team.

The implemented scripts were: ***Configuration templates, Jobs***, ***Data sources, KPIs*** (Key performance Indicators), ***Jobs, High charts***.

The second implementation was the Front-End development; for this purpose, the Framework ***Ember JS*** was used. Within the components developed with Ember JS are: ***custom-style-cellhourlyoutput-component*** and ***custom-style-crosstable-component.*** Those components improved the users experience when they worked with a boardlet based on a super generic table. Another critical aspect during the project was the testing phase, through this activity both bugs and incorrect parametrizations were found and fixed in the new releases of Legato Sapient, avoiding future reprocesses and customer complaints. The trace of the problems found were registered on ***Jira***, which is one of the tools used for this project.

Finally, the documentation supported each development, technical aspects were explained in detail.

Introduction

The Manufacturing Execution System Legato Sapient is a software provided by ***Gefasoft*** to the customers within the framework of automation industry, through this solution the machines behaviors are monitored by the customers, the goal of this monitoring is to improve the efficiency inside the factory. Once the data is collected by sensors and Programmable Logic Controller (PLC), this is processed, stored, and finally displayed in different user interfaces, with this data the customer can identify critical data during the machine's operation.

Gefasoft offers to its customers a support once they have acquired the license for using this service. Through this support ***Gefasoft*** keeps a direct communication with each project.
The customers can report and suggest new adjustments related to the functionality of Legato Sapient such as new user stories, bugs, or just new parametrizations. The ***IT Consulting team***, area where was performed this project should ensure the complete availability of Legato Sapient. In event that the customer needs were very specific, the customer proposed a list of new business logics, which should be developed, tested, and displayed into the customer environments. One of the projects led by IT Consulting team was the ***BMW project***, project in which was preformed this internship.

General objective

- Implement new business logics, which can be integrated with the existing functionalities provided by MES Legato Sapient within the framework of ***BMW*** project.

Specific Objectives

- Support and monitor the service availability offered by Legato Sapient.
- Provide functional developments which fulfill with the customer needs.
- Fix application failures on the servers where Legato Sapient is deployed.
- Report Bugs that can´t be corrected by IT Consulting Team.

Theoretical Framework

Legato Sapient is a system known as Manufacturing Execution Systems (MES). This type of systems monitors in real time each process performed inside the factory, Legato Sapient seeks to increase the efficiency during the production where a certain number of machines are involved.

One of the main interests on the Manufacturing Execution Systems is not only caused by the prominent results in the factories in terms of performance but the flexibility that this type of system offers regarding to the machine status monitoring given the great popularity of industry 4.0[1]. Exploiting the ease of the service offered by the cloud.

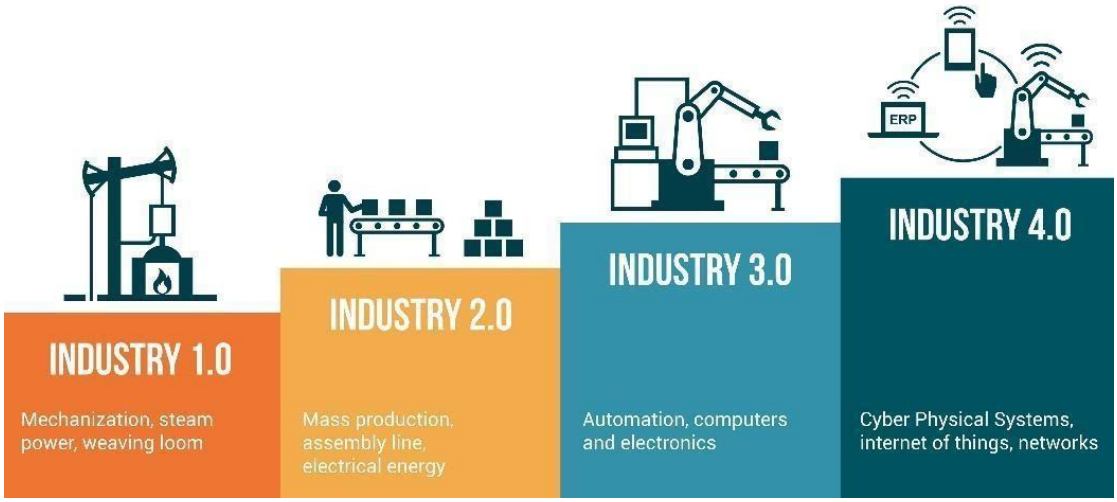

Figure 1: Industry 4.0 [4]

The industry 4.0 (Figure 1) refers to an organization model and control, which seeks to track each of the stages where a product is intervened, this approach uses the information technologies. The term of industry 4.0 was coined in Germany to refers to well-known fourth revolution industry, which massively adopts digital technologies such as the internet, the smart devices, artificial intelligent and the cloud computing [2][3].

Although the industry 4.0 is based on consolidated technologies such as the big data, cloud computing and the collaborative robotics, one of the elements which will strengthen the factory digitalization is the known as cyber physical systems. This type of systems is responsible to adapt the physical systems with devices which help them to have computing capacity. Becoming those machines into intelligent systems, able to interact with other external storage systems and database management such as the services which are provided by the cloud. Among the advantages found with the cyber physical systems are interconnection capacity, adaptability and data exchange rate. Keeping in mind those elements the productivity within the factory can be increased [5]

As was mentioned before, among the group of technologies which supported the fourth revolution industry is the cloud computing (Figure2), this approach offers service trough internet. The services supported by the cloud are:

- Resource storage
- Networks
- Data analysis
- Application development
- Machine Learning

One of the most important advantages offered by the cloud computing is the flexibility, by mean of the flexibility the services can adapt to customer needs better, either at software level or hardware level. Inside the group at software level is the well-known Software as Service (SaaS), under this approach the clients do not need to think about developments, deploys and maintenances, they only must think about the use of the services, which they have subscribed with providers, without considering the complexity of these systems [6]

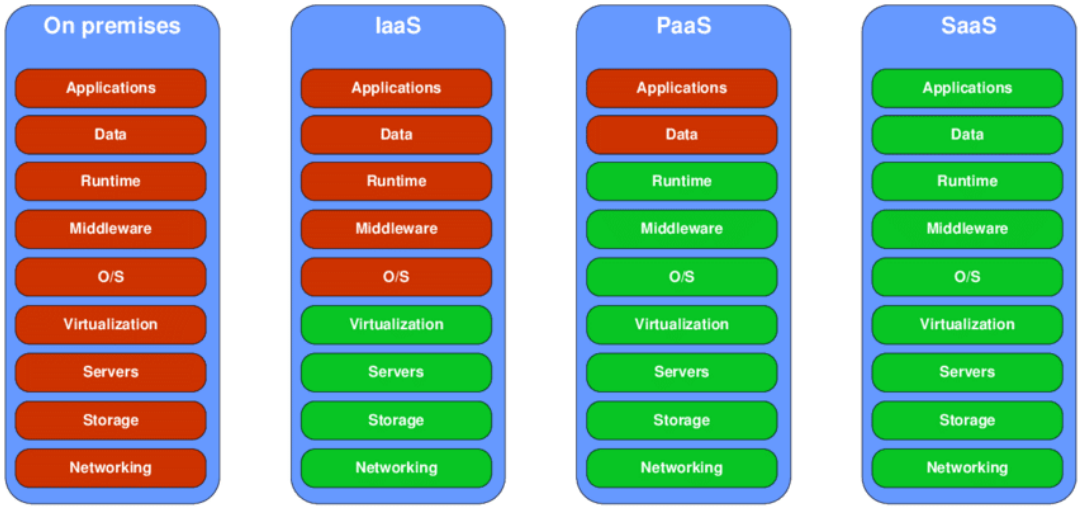

Figure 2: Type of services offered by the cloud***:*** IaaS, PaaS, SaaS [7]

Many systems are being reoriented given the popularity of the cloud services. One of these System is the well-known as Manufacturing Execution Systems (MES), this type of systems is seeking to migrate its Legacy versions into applications based on the cloud, given the flexibility offered by this paradigm. This new approach will help to those systems can grow in sustainable and fast manner, which will generate an impact both in terms of functionality and price [8]. In figure 3 was described the architecture of Manufacturing Execution System.

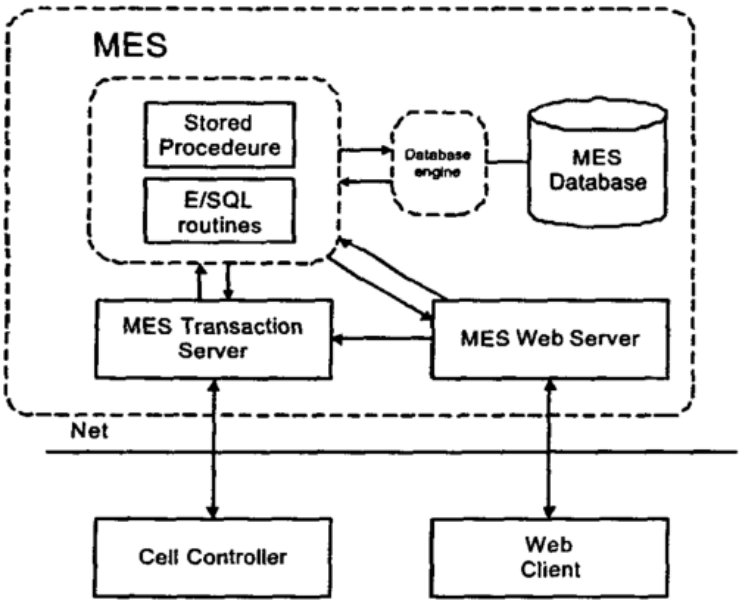

Figure 3: MES Architecture [9]

Methodology

During the internship was used an agile methodology as ***SCRUM***, by mean of this methodology was defined the workflow inside the project ***BMW***. At the beginning of the internship one of the members of the team explained all the preliminaries related to the project. The first fourth weeks were used for the induction phase, the topic covered during these weeks were:

- Tools such as LC2, ERP, Jira, Confluences repositories and IDEs
- Legato Sapient architecture
- Legato Sapient Instances
- Testing environments
- Custom Scripts structure
- BWM environments (CTE)

Once the induction phase was concluded, the project leader defined the first activities for being performed by the intern, the activates defined were:

- Scripts development such as Data sources, Configuration Template
- Testing and parametrization
- Documentation
- Front-End development

Regarding the Sprint reviews were scheduled every two weeks, during these meetings the user stories which had been proposed by the product owner were presented. In addition to the sprint reviews, weekly meetings took places with the IT Consulting team, by mean of these meetings the members of each project shared both the problems founds in the Legato Sapient.

Result and Analysis

Once the internship was finished, it was confirmed the fulfilment of the objectives proposed. As evidence of these achievements, three type of implementations were obtained at the end of the project.

The first result was the implementation of the ***Data source*** named ***hourlyouput***. This ***Data source*** pretended to provide an overview to the customer related to the number of pieces produced per hour within 23 hours range. The ***hourlyouput*** was used trough the ***boardlet*** generic-table. By mean of the boardlet generic-table, the client could select a group of nodes (Robots) which were displayed according to the node tree, once the nodes were selected, the procedure remote (Figure 4) was called via Http request by generic-table, this called referenced the script ***qry_hourlyoutput.js***. The remote produce returned the object generated by the script.

The above implementation was one of implementations which required more time during the project, however this first result left good impressions on the customer, because it fulfilled the costumer expectations.

It is important to remark that the number of versions (4) because of the constant readjustment of requirements; This implementation provided a new way for displaying critical data during the production in particular nodes (Robots). In the ***Figure 5*** can be observed the report in one of the test environments.

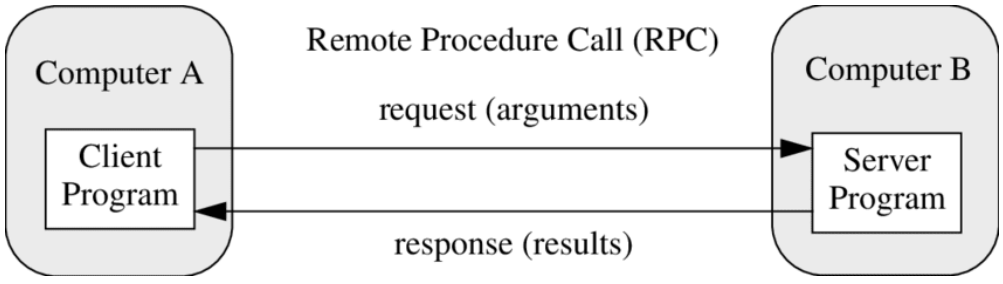

Figure 4: Remote Procedure Call (RPC) [10]

In addition to the first requirement defined by the customer, it was requested to include a new component for the ***boardlet generic-table***. The goal of this implementation sought to provide a better visualization to the client (User Experience). This requirement gave rise to component ***custom-style-cellhourlyoutput-component***.

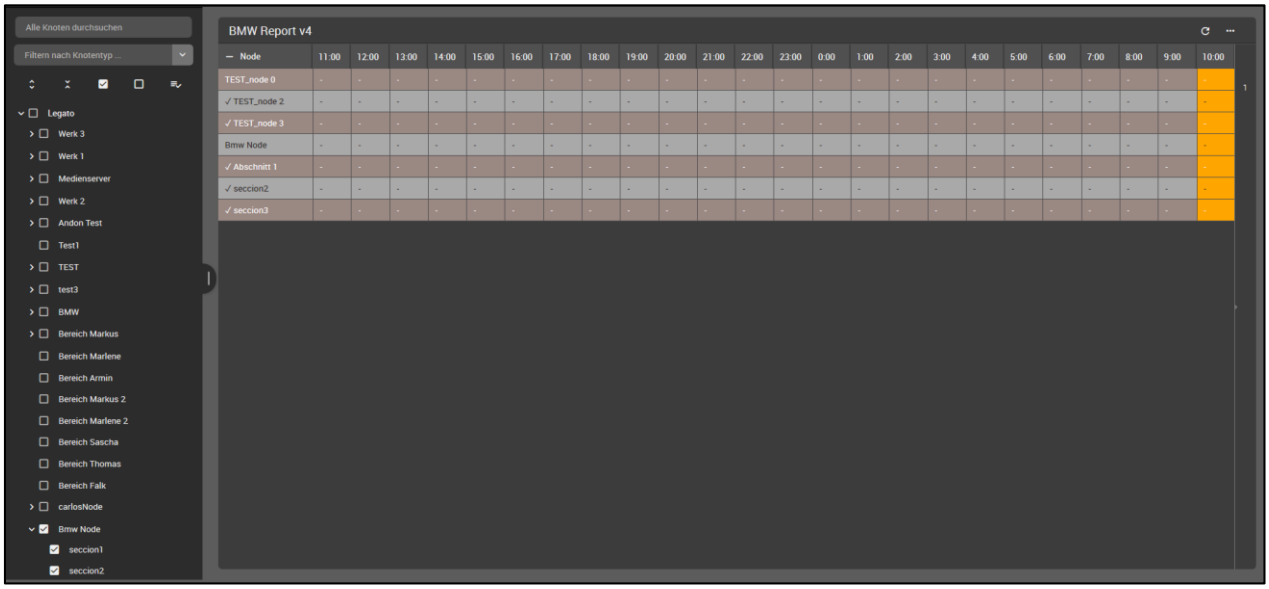

Figure 5: Report Hourlyouput [11]

The component ***custom-style-cellhourlyoutput-component*** is an Ember component, which helps to differentiate the adjacent rows with alternate colors, by mean of this component the user can parametrize dynamically the styles. This Functionality hasn´t been supported before by Legato Sapient. The parametrization should be defined in generic-table's configuration.

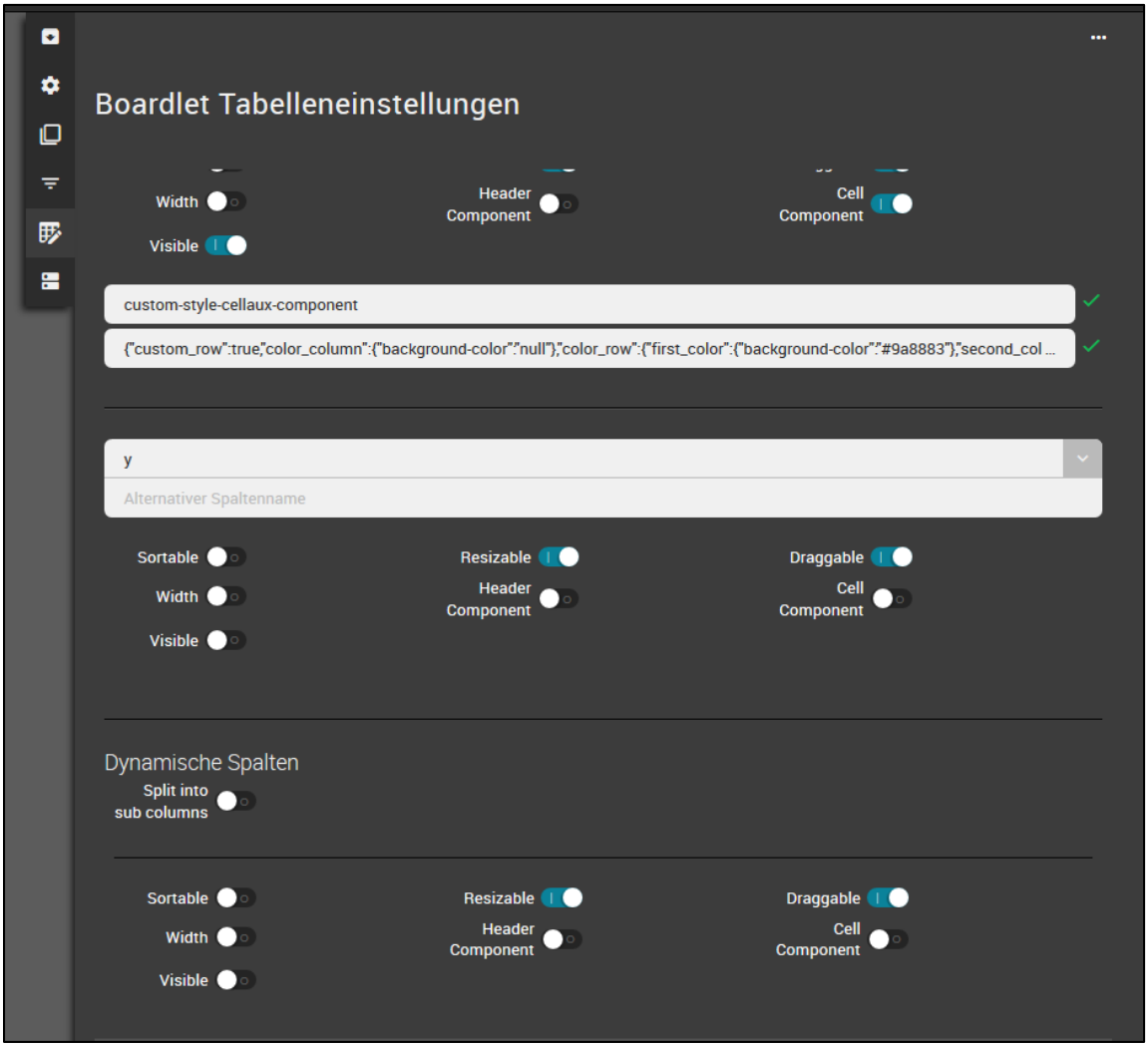

Figure 6: Ember Component (custom-style-cellhourlyoutput-component)

```
{
  "custom_row": true,
  "color_column": {
    "background-color": ""
  },
  "color_row": {
    "first_color": {
      "background-color": "#9a8883"
    },
    "second_color": {
      "background-color": "#a9a9a9"
    }
  }
```

Figure 7: Configuration(custom-style-cellhourlyoutput-component) [11]

custom-style-crosstable-component was the second component developed during the project, this implementation sought to add a new style to the ***boardlet cross table***, the section where the user wanted to predefine colors were: (rows, columns, and footer). In the figure 7 shows the boardlet with styles parametrized by the client.

Figure 8: Ember Component (custom-style-crosstable-component) [11]

```
{
  "style_column": true,
  "binary_column": true,
  "color_column": {
    "first_color": {
      "background-color": "#ff5733",
      "color": ""

    },
    "second_color": {
      "background-color": "#fbbdaf",
      "color": ""
    }
  },
  "style_row": true,
  "color_row": {
    "first_color": {
      "background-color": "#9a8883",
      "color": ""
    },
    "second_color": {
      "background-color": "#d8ccc9"
    }
  },
  "footer_color": {
    "background-color": "gray",
    "color": ""
  }
}
```


Figure 9: Configuration (custom-style-crosstable-component) [11]

The external help was the last result, this implementation helped to include a custom documentation inside the Legato help assistant, this implementation should be Bilingual (Support both English and German). By mean of this solution the project could add technical documentation related to developments which were created by the team (Figure 8).

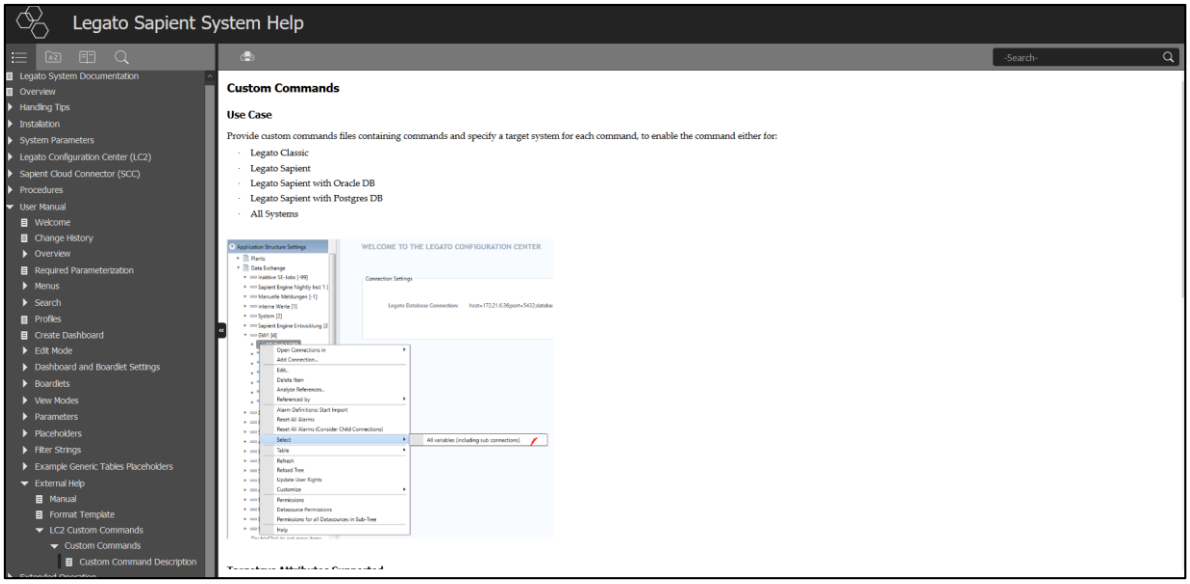

Figure 8: External Help Files Legato Sapient [11]

Conclusions

Through this project the Sapient functionalities were strength, providing solutions which could be better adapted according to the customer needs, with high level of quality in term of availability and scalability. To achieve this objective, the project defined different type of implementations based on business logic, additionally the implementations of ember components helped to improve the data visualization provided by the boardlets ***generic-table*** and ***cross-table***.

On the other hand, both the test and the reports were crucial for the project, by mean of them bugs and wrong configurations were detected. Finally, during the project a constant support was provided to the team, adding value to each activity performed such as implementations, technical documentation, and customer support.

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