IDAC: A Sensor-Based Model for Presence Control and Idleness Detection in Brazilian Companies

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Summary

Introduction

- Growing adoption of the **Internet of Things**, where RFID appears as the most used sensor technology to turn IoT into a reality.

- Among the various situations of our daily lives that can be optimized using context-awareness, there is the **clocking**.

- In a company with hundreds or thousands of employees, it is hard to identify how **productive** the time spent by the employees at the company actually is.

- The idea is to allow not only to control entry and exit times, but also to view how much time each employee spent on each of the company's areas.

Related Work

Work	Technologies	Passage Record	Identify Location	Idleness Detec-tion
(Neiva, 2012)	RFID	No	Current	No
(Pereira, 2012)	RFID and Biometrics	Incoming and outgo-ing	No	No
(Ahgora, 2015)	RFID and Biometrics	Incoming and outgo-ing	No	No
(CH&TCR, 2015)	RFID	Incoming and outgo-ing	Current and traveled route	No

Related Work

GAP:

- Many of the approaches are still based on the employee's **conscious choice** to record his presence using a tag in a reader, not exploiting the capacity of automatizing this process.

- Other approaches that identify where the staff members are after the registration, do not use this data in order to identify possible **idleness patterns**.

Model

IDAC:

- A context-awareness model to both **control presence** and **detect idleness** using sensors to indicate the movement of employees within the environment of Brazilian companies.

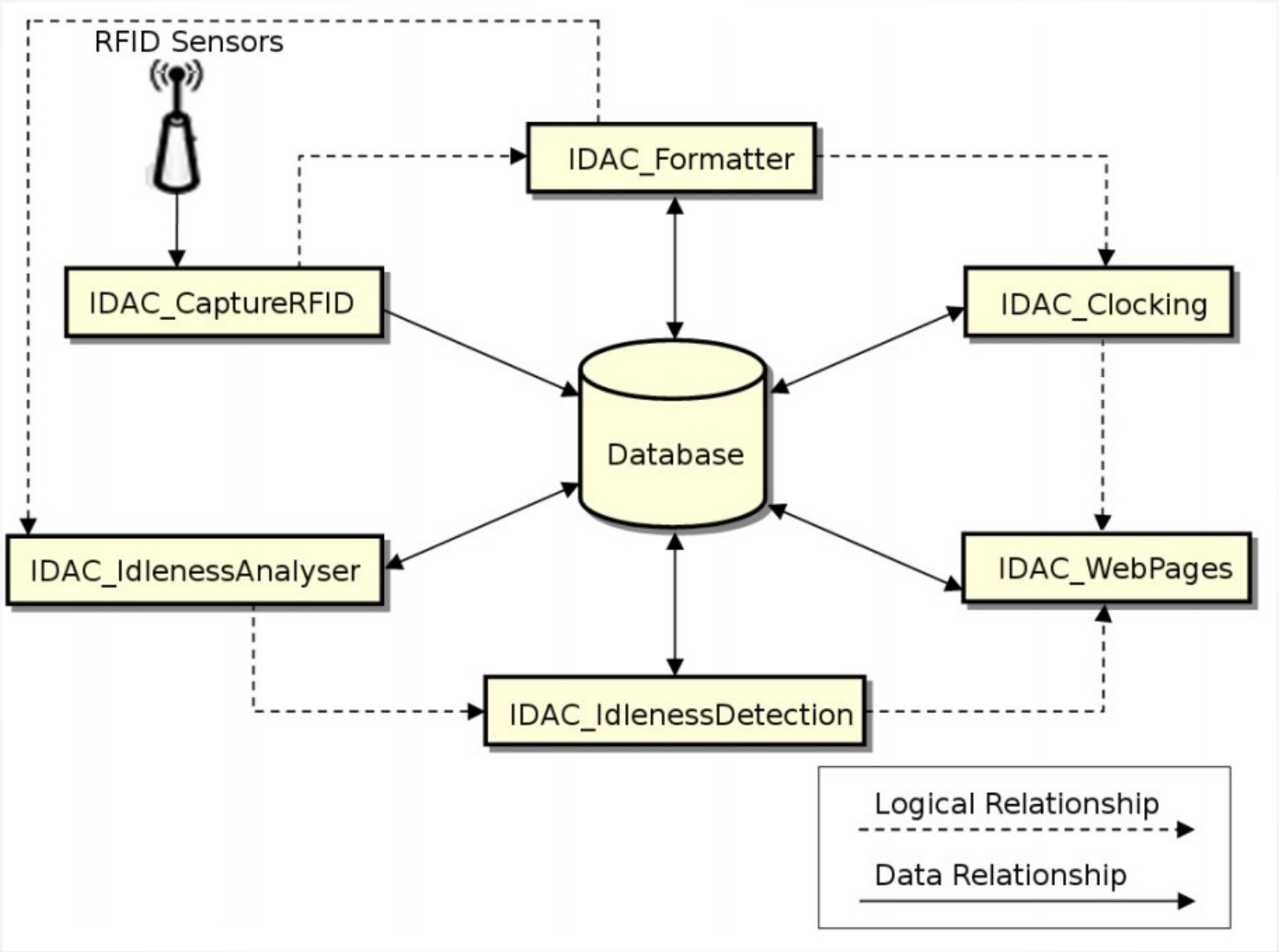
- The model assumes that there are RFID readers scattered throughout the company environment, which can identify employees who pass by them. Each employee **must have a tag** that enables the system to identify him and carry it with him through their whole shift.

Model

Idleness Detection: record all the **passages of employees** through business environments, so that whenever an employee stays more than a certain time away from their workstations, the system is able to identify and store this information.

Groupings: It identifies when groups of two or more employees are out of their jobs, **characterizing a grouping**, and when an employee receives a visit of others at his workstation.

Modules


RFID Sensors
IDAC_Formatter
IDAC_CaptureRFID
IDAC_Clocking
Database
IDAC_IdlenessAnalyser
IDAC_WebPages
IDAC_IdlenessDetection
Logical Relationship
Data Relationship

Modules

IDAC_CaptureRFID: responsible for receiving the data captured by RFID readers and store it on the database. Information for each capture: the read tag's identifier, **a timestamp** and the reader identifier.

IDAC_Formatter: responsible for **pre-processing** the raw data captured by the previous module. If it is a time-card sensor, it creates a Clocking Marking, otherwise it is instantiated as a Passing by Marking.

Modules

IDAC_Clocking: process the Clocking Markings and Forced Markings. At this stage, a new type of data is created **Worked Day**, which will store all markings, forced or not, in a list based on the date and the employee to which they belongs. In case of extra events such as: Notifications, Overtime or Negative Time, data of same type is created and stored in the database.

IDAC_WebPage: this is the module that allow the Forced Markings to be included, overtime to be justified and markings/idleness to be viewed. It is the **Management Tool**.

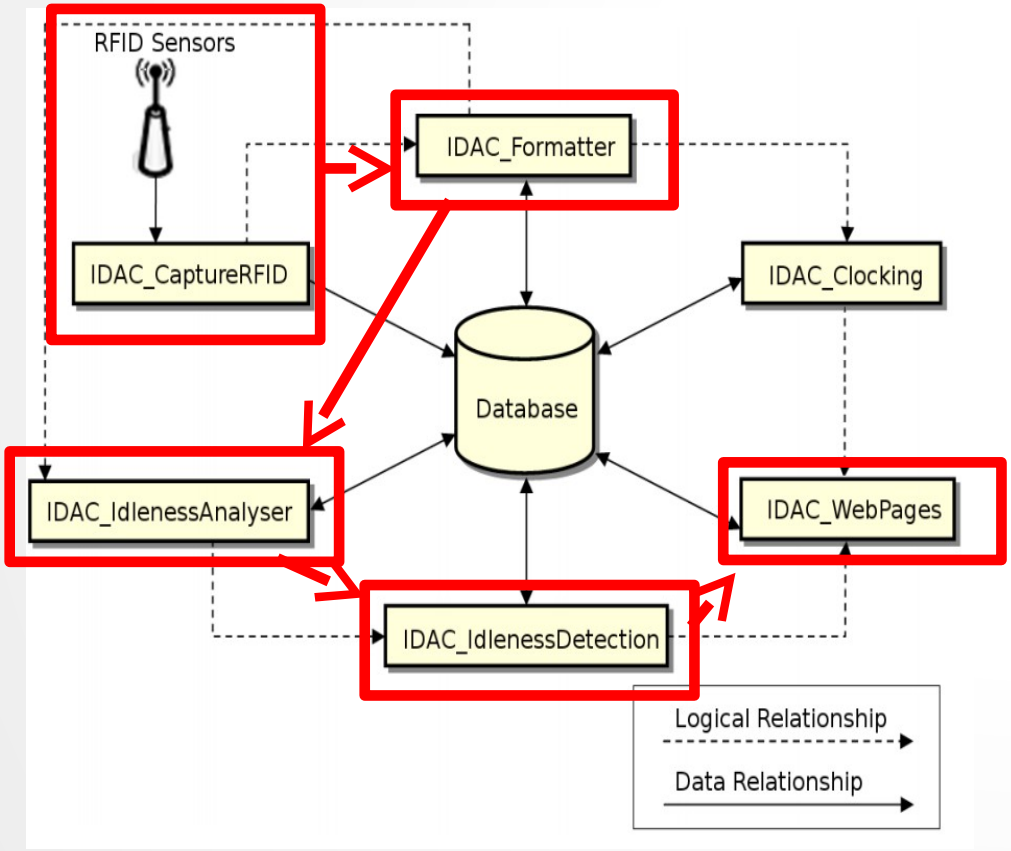
Modules

IDAC_IdlenessAnalyser: process the Passing by Markings. Each pair of markers identifies the exit from a place and the arrival into another and a new data type called Pass is created. It stores the **places** that the employee has been to, **time spent** in this place and **who** is the employee.

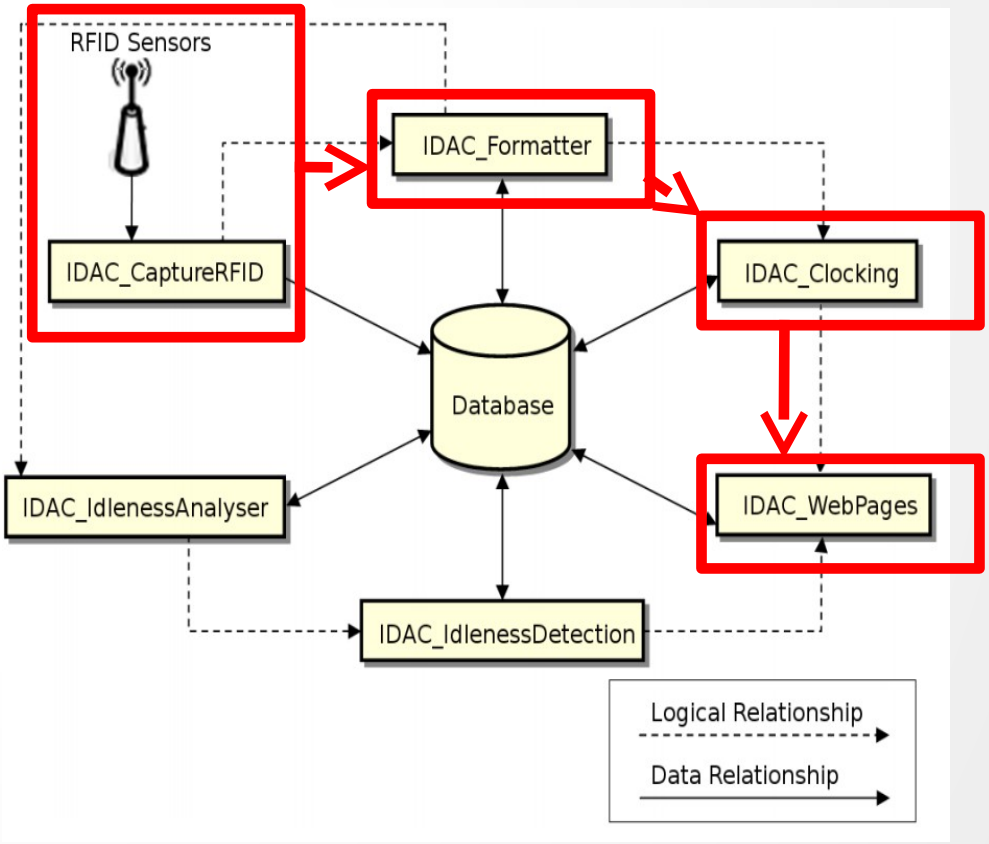
IDAC_IdlenessDetection: identifies where the employee has been too and the time spent in each environment, using the Pass and Worked Day data types. Thus, if it is detected that an employee has exceeded the stay time limit set by the Manager, not complied with the minimum of daily activity or was part of a grouping, the system identify an **idleness behavior**.

Information Flow

Stream 1



Stream 2



Actors

Manager:

This actor must have access to the markings of all employees, be able to justify all situations that escape the normal workday, make markings manually and validate justifications and markings recorded by employees.

Employee:

He must have his markings automatically registered and have investigated his idleness. Thus, he has the obligation to carry with him a tag (RFID wristband) for identification.

Features

Idleness Detection

- Inclusion of Places
- Sensors Inclusion
- Passage Registration
- **Detection of Groupings**

Clocking Markings

- Clocking Record
- Lunch Time Validation
- Extra and Negative Time Record

Evaluation Methodology

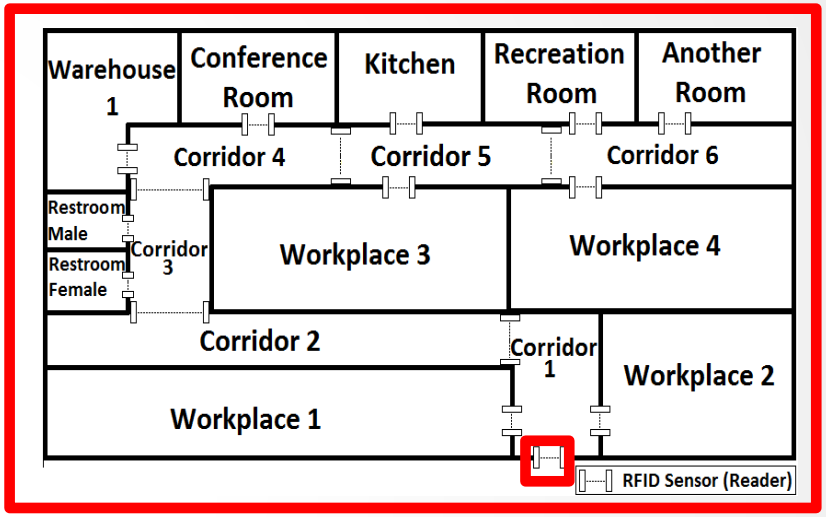
- Survey data for analysis was gathered through **simulations**.
- The simulator builds a **path** to be followed by a theoretical employee in a working day of the simulated company.

  2 Approaches:

  - **Functionality test**, where the system would run tests for a given scenario and collect the application's results for a theoretical group of employees.
  - **Stress test** in order to verify the limits on the load of the application that process information.

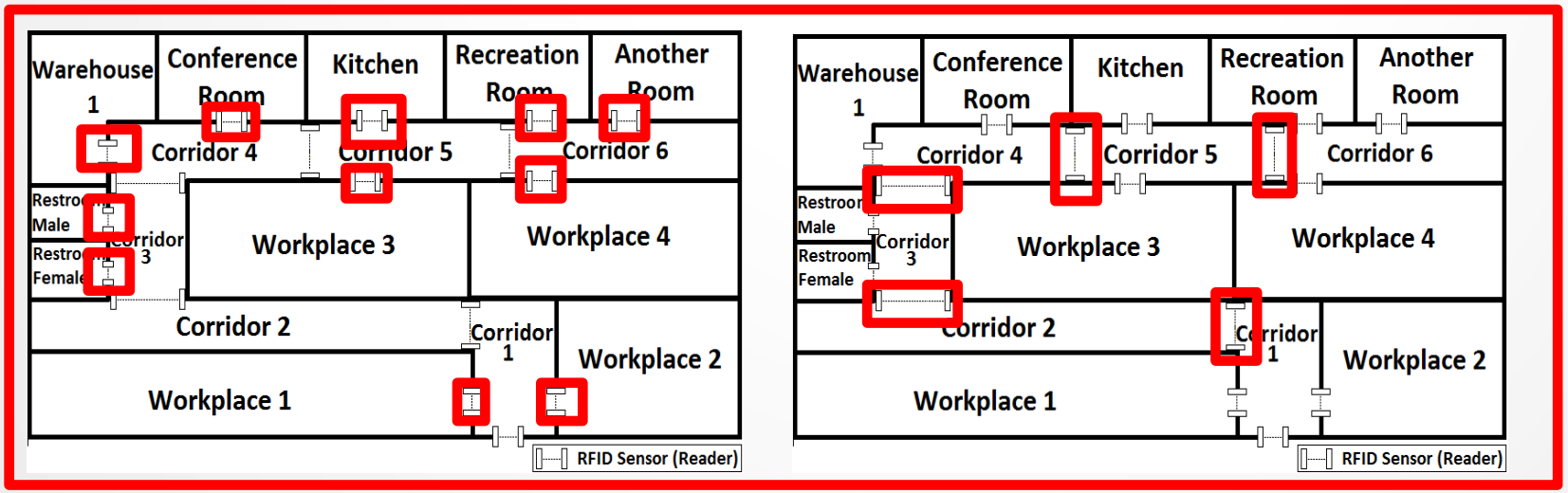
Evaluation Methodology

Theoretical plant with 17 distinct environments, each of which is a place where the system is prepared to apply specific rules in order to **detect idleness**.



Time-card sensor

RFID sensors

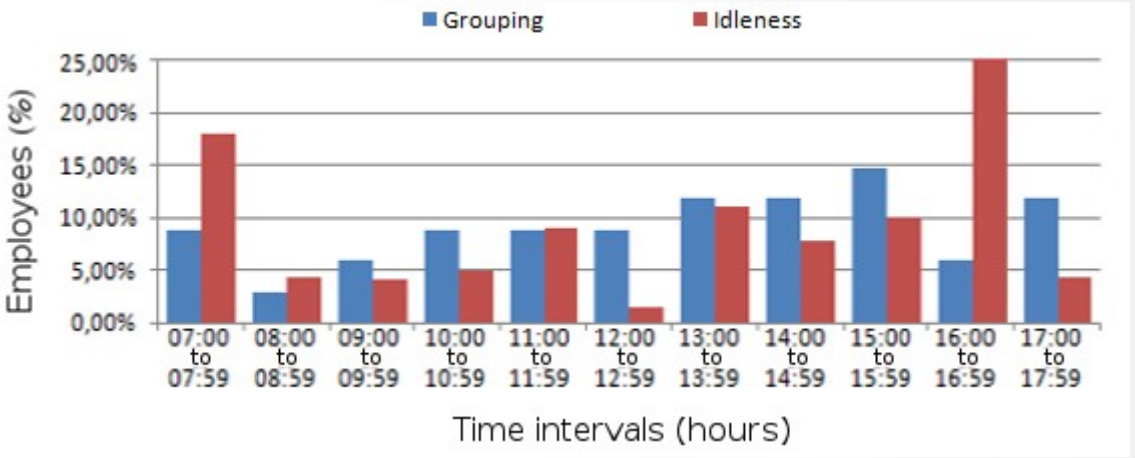


Results

Experiment 1:

#Employees: 80

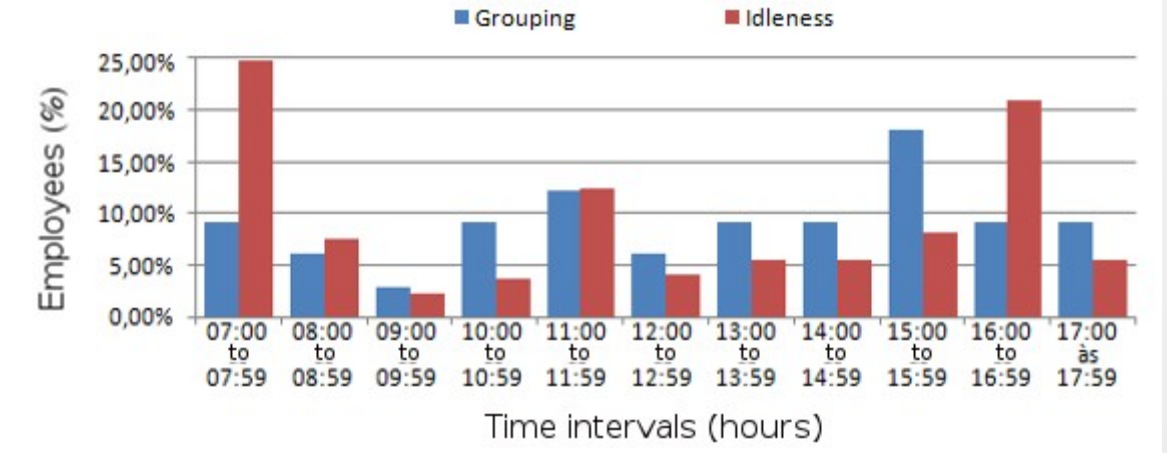
Company: Molas Weber



Experiment 2:

#Employees: 143

Company: Perkins

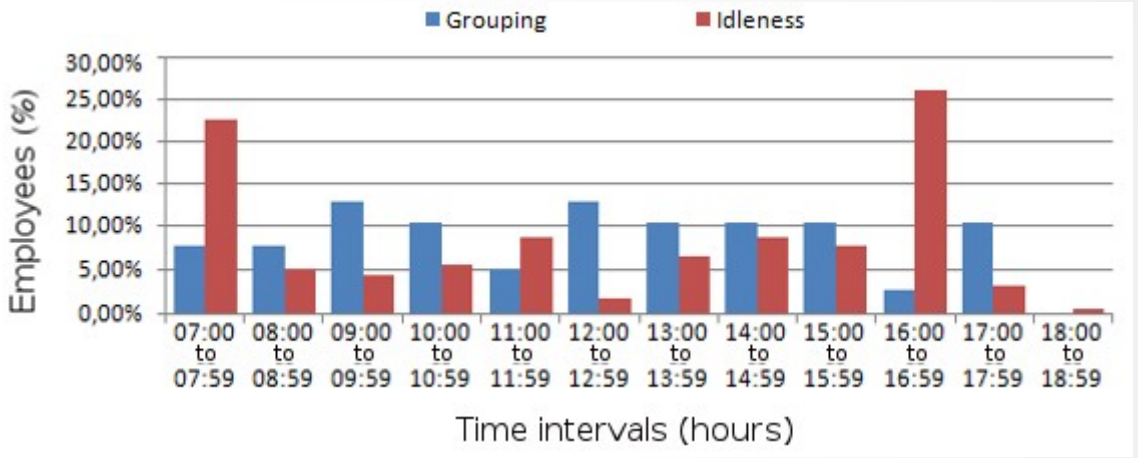


Results

Experiment 3:

#Employees: 356

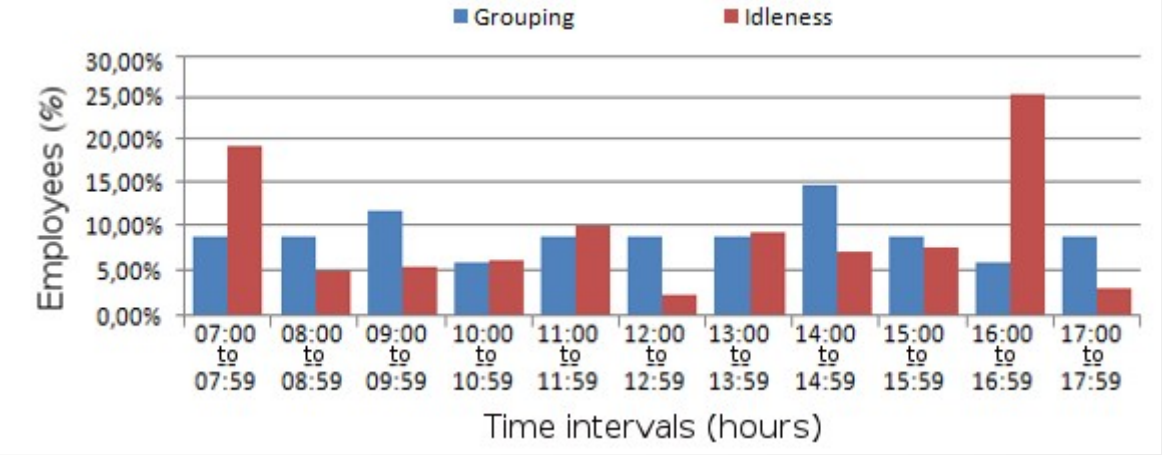
Company: Zanzini



Experiment 4:

#Employees: 400

Company: Jost Brazil

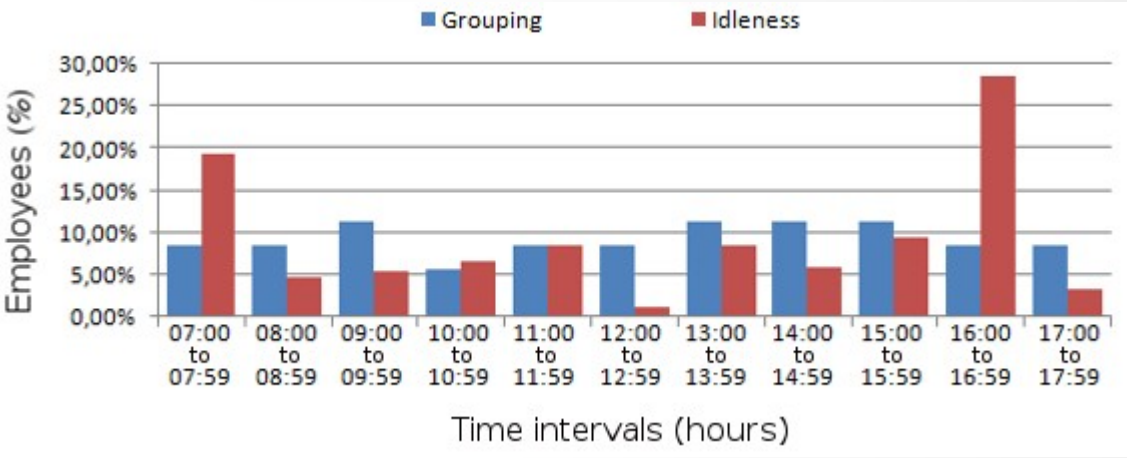


Results

Experiment 5:

#Employees: 482

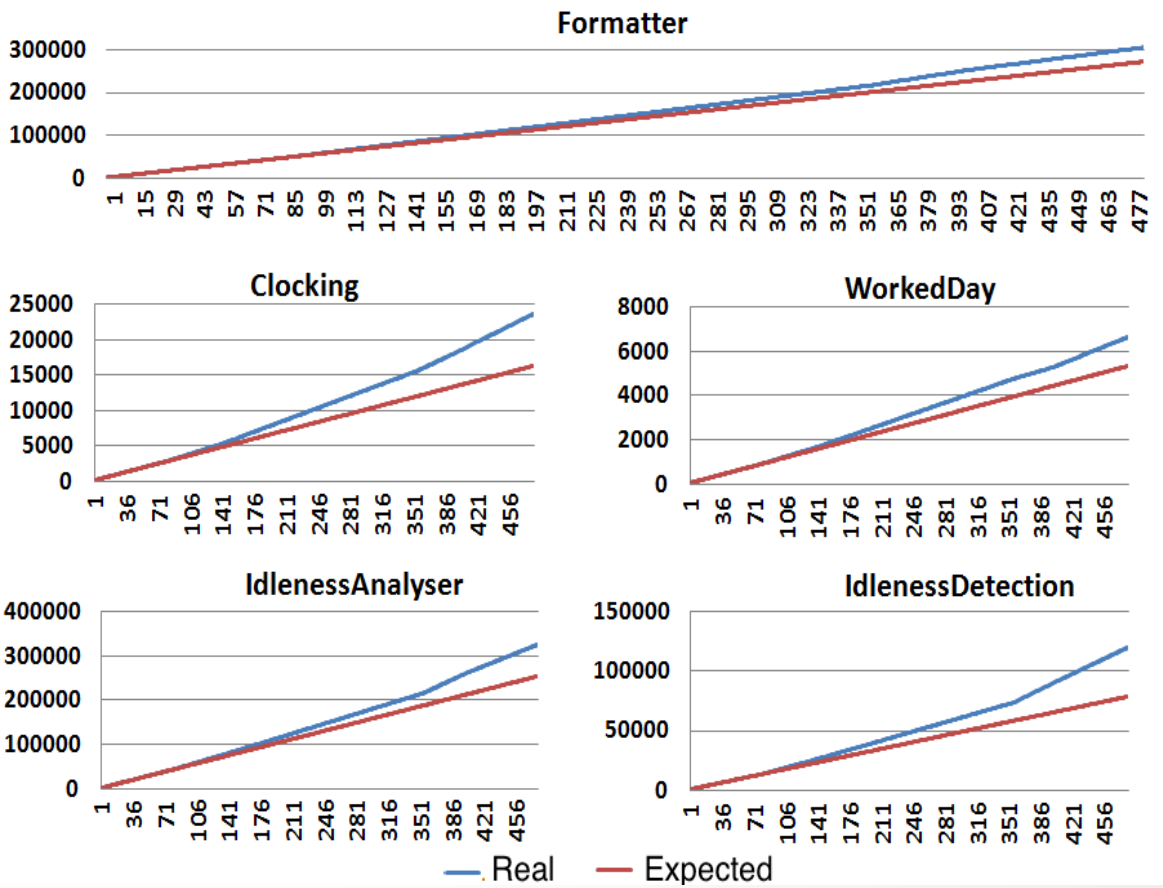
Company: Portas Pormade



Based on the data collected through tests and simulation, we note that there is evidence of system usability and its ability to **perform the clocking**, as well as **raise all idleness** and **groupings** for the theoretical groups of employees.

Performance

The graphics bring the execution time, depending on the number of employees, slightly above the linear, suggesting that the system has an excellent performance, being able to process even larger batches of employees.



Conclusion

- Based on a set of rules that can be **changed dynamically**, the system is able to identify situations that flee from the managers interests and adapt to a wider range of companies.

- The system was able to identify the idleness and groupings of theoretical employees for every performed experiment.

Future work:

  - **Framework decentralization**, using a distributed database (the current bottleneck).

  - Implement the system in a **real business environment**.