CRANFIELD UNIVERSITY

ESTER COVES QUILES

SIMULATION TO GENERATE DYNAMIC DATASET TO SUPPORT
DATA ANALYSTS TRAINING

SCHOOL OF AEROSPACE, TRANSPORT AND
MANUFACTURING
MSc in MANAGEMENT & INFORMATION SYSTEMS

MSc
Academic Year: 2016 - 2017

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This thesis is submitted in partial fulfilment of the requirements for
the degree of MSc in MANAGEMENT & INFORMATION SYSTEMS

ABSTRACT

Data analytics professionals are expected to extract insights from data and find relationships that are significant for the business. The preparation of good training data is difficult. Real trading data could be available, but the instructor cannot change the scenario parameters and the data may include unknowable factors. To gain better learning control, the instructor can create the data. But this is extremely time consuming, especially if multiple datasets are needed for trainees with different skill levels.

This project creates a simulation tool to generate dynamic datasets for training business data analysts. A model simulating the interaction between the call centre, sales and technical support departments of a company was developed using the AnyLogic simulation platform. Datasets representative of CRM and ERP records are generated for data analysts training. An instructor can easily change the simulation parameters and create datasets that represent different business problems. Dataset for four business scenarios were generated and validated as effective for business data analyst training.

Keywords:

Business data analytics, talent shortage, enterprise modelling, AnyLogic, scenario, data quality

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LIST OF ABBREVIATIONS

IT	Information Technology
BDA	Business Data Analytics
TS	Technical Support
CC	Call Centre
MIT	Massachusetts Institute of Technology
TSG	Training Scenario Generator
MIS	Management & Information Systems
EM	Enterprise Modelling
SD	System Dynamics
DES	Discrete Event Simulation
ABM	Agent Based Modelling
DS	Dynamic Systems
ATFM	Air Traffic Flow Management

1 INTRODUCTION

1.1 Motivation

Nowadays, business data and analytics are far more important in an enterprise than they previously were. New technology has allowed any organization to gather, store and access huge amounts of data regarding its various operations. Not only is the available data today more extensive, but also more complex, as companies intend to analyse data from many new and varied sources. With all this data on hand, companies try to apply data-driven business practices internally and externally, to improve real-time decision making and their performance across the whole company.

However, it is not the amount of data what matters, but the ability to do something with it. It is here where data analytics professionals are required to extract insights from the data and find the relationships that are significant for the enterprise. According to the *2015 MIT Sloan Management Review* (Ransbotham, Kiron, & Prentice, 2015), there can be a gap between a company's capacity to produce analytical results and its ability to apply them effectively to business issues if there is a lack of data analytics talent.

As a result of the relentless pace of technological innovation and fast-changing culture, there is a shortage of talent in data analytics and many companies are struggling to find data analysts to hire. Therefore, there is a need of training business data analysts to fill this talent gap.

The main problem is that preparing good training data might be difficult. Sometimes, real data of a company can be available, but this means that the instructor cannot control the scenario parameters and the data might include unknown varieties. On the other hand, the instructor can directly create the data, but this option is extremely time consuming, especially if several dataset are needed for trainees with different skill levels.

Training should be provided under a controlled environment, with personalised mock data generated by the trainer. This data should be adapted to the trainee

skill levels and allow them to validate their extracted insights and so, test and improve their skills.

Considering these facts, the thesis aim and objectives are defined.

1.2 Thesis aim and objectives

The aim of this project is to build a model that generates dynamic datasets that simulate the interactions between the call centre, sales and technical support departments of a fictitious company (Longtau Technology) for training business data analysts.

The objectives of this project are:

- Model Longtau Technology company using AnyLogic software
- Create a user interface to enter the company attributes and dataset complexity as inputs
- Generate datasets in Excel file
- Define and validate three different scenarios for Longtau Technology

1.3 Project deliverables

The deliverables of this project are:

- Simulation tool (model and interfaces)
- Scenarios simulation and validation
- User guide to generate datasets using the tool

2 LITERATURE REVIEW

This chapter is aimed at presenting the theoretical base of the project and the state of the art. The literature review focuses on four main topics: scenario generation, characteristics of good datasets, analysts training and enterprise modelling.

2.1 Scenario generation

Simulation-based training is widely used to train military personnel, NASA astronauts, flight controllers and employees from many industries (Loftin, Wang, & Baffes, 1989). One of the issues that appears in the development of a simulation-based training system is the effective and quick generation of scenarios. These simulated scenarios should represent with high accuracy the task environment and help the trainee to improve their skills. However, scenarios are usually consumed faster than they can be generated, so scenario generation has become a critical bottleneck to the training system (Zook, Lee-Urban, et al., 2012)

During the last decade, researches have investigate how to generate customised and adaptive scenarios. Magerko, Stensrud, & Holt (2006) and Magerko, Wray, Holt, & Stensrud (2005) proposed to model the trainee's proficiency to the domain-specific skills using a skill model with different states that were dynamically updated in real-time. Depending on the skill model state, different scenarios were selected for the trainee. Thue, Bulitko, Spetch, & Romanuik (2011) used a player model to identify the player favourite styles and automatically select the categories in an interactive story. In these works, the adjustments were made locally at particular instances during the simulation and games.

Many researches have also focus in generating personalized scenarios before the actual simulation. Yu & Riedl (2012) developed an optimization process to generate scenarios that chases the appropriate sequence of events to achieve the established training goals. Luo et al. (2008) also proposed an optimization

process for scenario generation, but emphasizing the trainer's preference and controllability and the adaptation to the trainee's skill levels.

2.1.1 Scenario generation frameworks

There are different approaches to scenario generation. In this section, two different frameworks will be reviewed.

Luo et al. (2008) developed an interactive and iterative process for mission-based scenario generation for training. This model represents a cycle that considers both trainer and trainee. In this model, the trainer first selects the mission objectives and generates a set of scenarios based on these selected missions and on the predicted trainee's skill levels. Then, these scenarios are simulated by the trainee and an assessment of the trainee performance is generated. Finally, the trainer obtains the trainee's performance evaluation and generates a new set of datasets according to the new skill level of the trainee, creating more challenging scenarios every time that the trainee's performance has been improved. Figure 1 shows this iterative process:
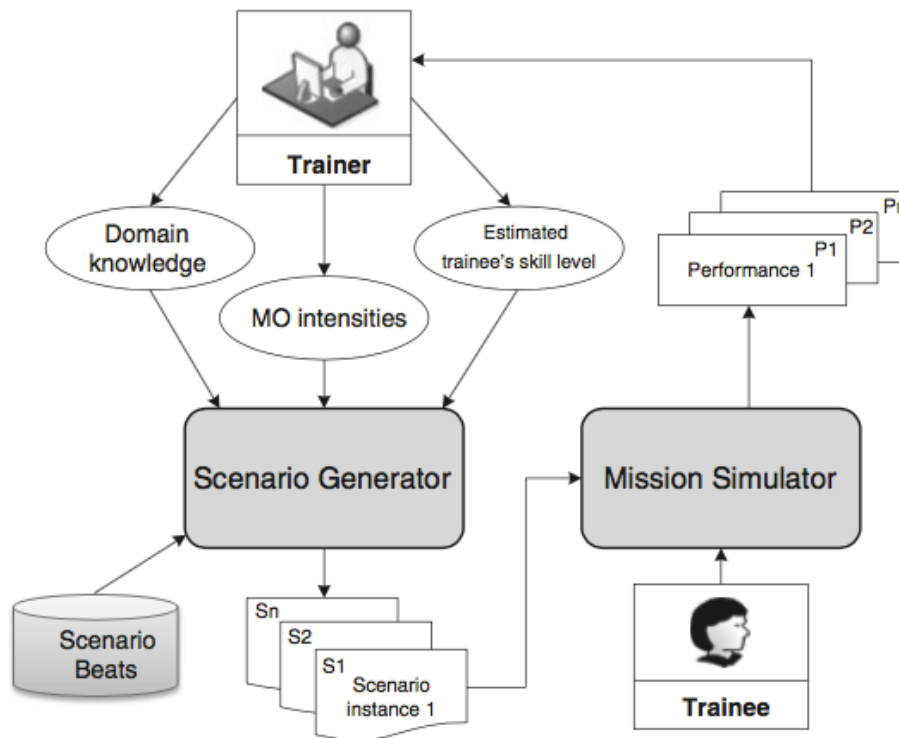
Figure 1: Framework of mission-based scenario generation (Luo et al., 2008)

The Artificial Intelligence Section at NASA/Johnson Space Center (JSC) developed an intelligent training system for astronauts, flight controllers and system engineers (Loftin et al., 1989). One component of this system was the Training Scenario Generator (TSG), responsible for generating customised scenarios for each system user. The TSG is composed of two main parts: a knowledge base in the form of rules to assess the trainee's skill level, and an object database that assembles the different parameters to generate the scenarios. The TSG accesses the trainee history and the created scenario is displayed to the trainee and the trainer in the system blackboard, as shown in Figure 2.
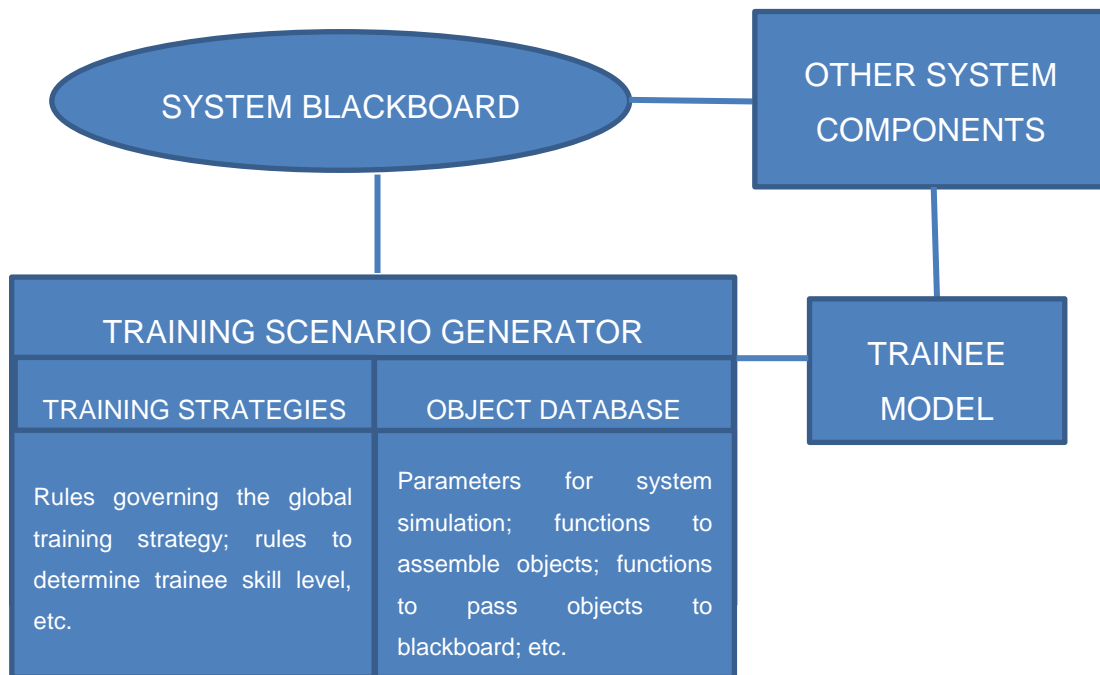
Figure 2: Integration of the Training Scenario Generator in the NASA training system (Loftin et al., 1989)

2.2 Good dataset characteristics

A dataset is a collection of data in an organized structure intended for automated analysis. Datasets are always created with a purpose, to analyse a situation or extract insights from the data.

Datasets generated to support data analysts training should be as close as possible to the actual data the trainees expect to see and work with in the future. Besides, these datasets should have some characteristics in order to allow trainees to improve their skills:

- Be represented in a structure that reveals the characteristics of individual data items and their relationships.
- Have clear semantics of the data elements and their relationships. The semantics may be described explicitly within the dataset, in a separate document or implicit through compliance with an external specification.
- Be structured in a way that allows future efficient computation using general-purpose or domain-specific software.
- The dataset format should consider the intended use and domain-specific requirements, as different data types might be needed for values or attributes within the dataset. A widely used format is the CSV (comma-separated values), which is usually limited to character-based representation of text and numbers.
- Be properly labelled.
- Good coverage of all the operational parts of the desired input space, with satisfactory density.
- Low noise/variance of the irrelevant things.
- High data quality.

Finally, the instructor should avoid using a biased subset of possible training examples. Each dataset should be personalised to the trainee, and the amount of data needed will depend on the skill level that the trainee is expected to reach.

2.2.1 Data quality

There are six core characteristics of good quality data (DAMA UK Working Group, 2013), presented in Figure 3:

Figure 3: Data Quality Dimensions (DAMA UK Working Group, 2013)

- **Completeness:** absence of blank (null or empty strings) values, all datasets and data items are recorded.
- **Uniqueness:** a single view of the dataset, anything will be recorded more than once based upon how that thing is identified.
- **Timeliness:** data should be captured as quickly as possible after the event or activity and must be available for the intended use within a reasonable time period.
- **Validity:** data are valid if it conforms to the syntax of its definition and should be recorded and used in compliance with relevant requirements, including the correct application of any rules or definitions.
- **Accuracy:** data correctly describes the "real world" object or event that it describes.
- **Consistency:** data is the same across all the instances at any given time.

There are other characteristics of good quality data like reliability, relevance or integrity.

2.3 Data Analysts Training

Every time, more organizations are using data analytics to maintain their competitive advantage and so, the demand for business data analysts is continuously increasing at a fast pace. Hence, is not surprising that there is a talent shortage of BDA professionals, but what makes this shortage more complex than that in other fields is the broad set of technical, analytical and business skills required for these professionals (Clavier, Ph, & Brar, 2010).

The *2015 MIT Sloan Management Review* (Ransbotham et al., 2015) finds that the principal barriers to creating business value from analytics are not data management or modelling skills, but translating analytics into business actions, and that talent management is critical to realizing analytics benefits. 43% of the surveyed companies reported they were struggling to hire and retain BDA talent. As a result of the scarcity of data scientists, more than 60% of the companies are providing formal in-house training. Besides, 49% of these companies are training existing managers to become more analytical and at the same time, 34% are training data analysts to better understand their business. Nevertheless, more than half of the surveyed companies pointed out that one of the main challenges was translating analytical insights into business actions.

The BDA talent shortage is also a consequence of the declining enrolment in MIS programs (Aken & Michalisin, 2007). One of the causes of this decline is the quality of the programs. Many researchers (Cheney, 1988) (Watson, Young, Miranda, Robichaux, & Seerley, 1990) have sought to determine the organization skills requirements for IS professionals with the purpose of correlating what students are taught and what employers seek from their MIS professionals. Aken & Michalisin (2007) identified a list with the most important skills. These skills were divided in soft skills, non-technical hard skills, technical hard skills and programming hard skills, Table 1.

Soft skills	Business skills	Technical skills	Programming skills
Problem-solving skills	**Business processes**	**Software development**	**Current languages**
Ability to learn	Accounting	Agile development	.NET
Attention to details	Business process design/re-engineering	CASE tools	AJAX
Business problem solving	Contracting and legal	Client-Server	ASP
Creativity	Finance	Programming	C/C++
Critical thinking	Marketing	SDLC	C#
General problem solving	Supply chain management	System testing	ColdFusion
Research skills	**Management skills**	Systems analysis	HTML/XHTML/DHTML
Working under pressure	Managing 3rd party providers	Systems design	Java/J2EE/J2P
Interpersonal skills	Outsourcing management	User-interface design	Perl
Conflict resolution	User relationship management	Web-based application development	PHP
Interpersonal relationships	Working globally	**Business applications**	SQL
Leadership	Working with virtual teams	Applying IT to business	Visual Basic
Self-esteem	**Project management**	Customer relationship management (CRM)	XML
Teamwork	Project management/ Planning/Budgeting/ Scheduling	DSS/GDSS	**Legacy languages**
Work ethic	Project risk management	Enterprise resource planning (ERP)	Ada
Initiative/Motivation to work	**Strategy skills**	Operating systems	COBOL
Integrity/Honesty/Ethics	Business intelligence	Transaction processing systems	Smalltalk
Responsibility	Business strategy	Web servers	
Self-management	Project integration	**Information management**	
Time management		Data mining	
Language skills		Data warehousing	
Negotiation skills		Database administration	
Oral communications		Electronic data interchange	
Questioning skills		Online analytical processing (OLAP)	
Written communications		**Hardware**	
		Business continuity planning (BCP)	
		IT architecture/ Standards	
		Network administration	
		Security	
		Voice/Data telecom	

Table 1: Skills categorization

If schools tailor their MIS curriculum to the industry needs, the enrolment in MIS programs will rise again and the BDA talent shortage will be reduced.

2.4 Enterprise modelling

2.4.1 Definition

A model is a representation of another thing, either as a physical object that is usually smaller than the real object, or as a simple description that can be used by people (modellers, users) in calculations.

The definition of an Enterprise Model by Gruninger and Fox is the following:

"An Enterprise Model is a computational representation of the structure, processes, information, resources, goals and constraints of a business, government activity or an organizational system. It can be both definitional and descriptive – spanning what should be and what it is. The role of an Enterprise Model is to achieve model-driven enterprise design, analysis and operation." (Gruninger & Fox, 1996)

Doumeingts and Ducq (2001) added to the definition of an EM that besides the technical aspects of the model, the economic, social and human aspects also need to be considered. Enterprise modelling techniques should be able to describe operations of an enterprise in terms of objectives and functionalities, but also in terms of evolution and relationships with its environment (customers and suppliers).

In today's dynamically evolving environment, successful management decision making should be agile and flexible. The use of simulation modelling is now considered an essential feature in companies if they want to remain competitive.

The essence of EM, according to Serova (2013), is to obtain both quantitative and qualitative findings from the model. These insights will allow to make a forecast of the model variables values and discover previous unknown features of the system like trends or integrity issues, respectively. Thus, such models

should help to understand the current situation and find improvement opportunities.

In their research, Persson and Stirna (2001) identified the most common objectives that organisations have when using EM. These objectives are divided in two categories: developing the business and ensuring the business quality. Figure 5 presents the identified objectives:
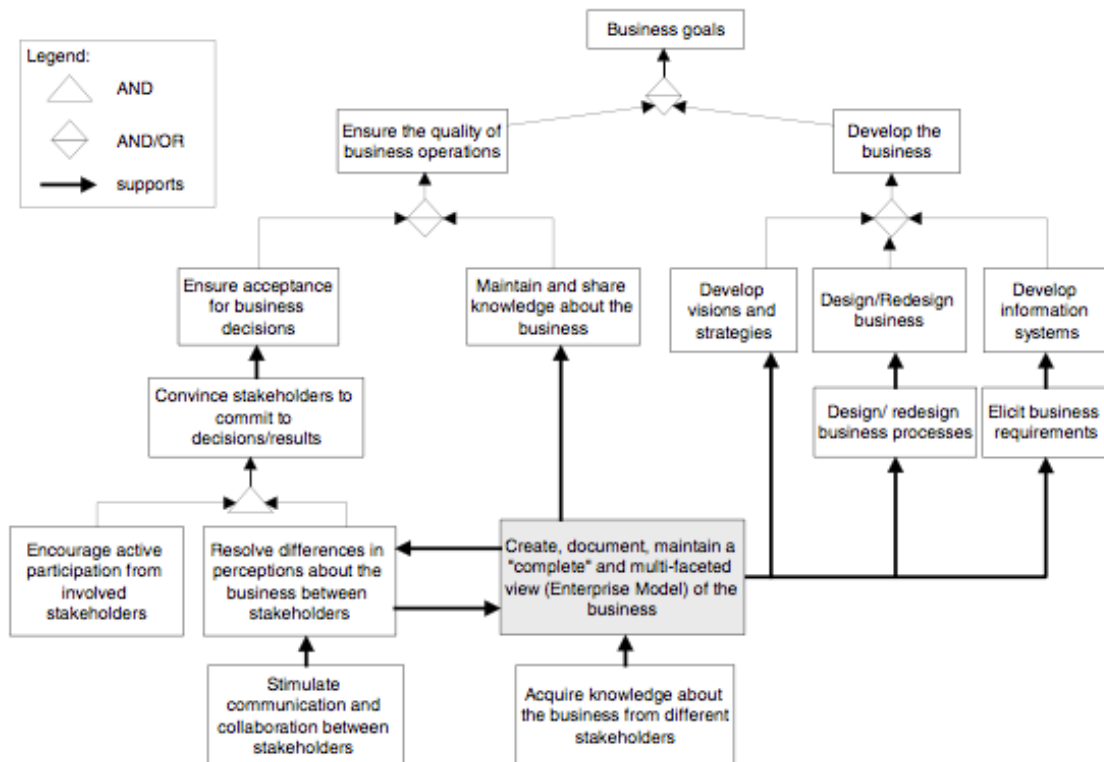
Figure 4: Goal hierarchy of the most common intentions for using EM (Persson & Stirna, 2001)

2.4.2 Major paradigms

There are three major paradigms in simulation modelling: Discrete Event Simulation (DES), Agent Based Modelling (ABM) and System Dynamics (SD). Figure 7 relates these approaches to the different levels of abstraction:
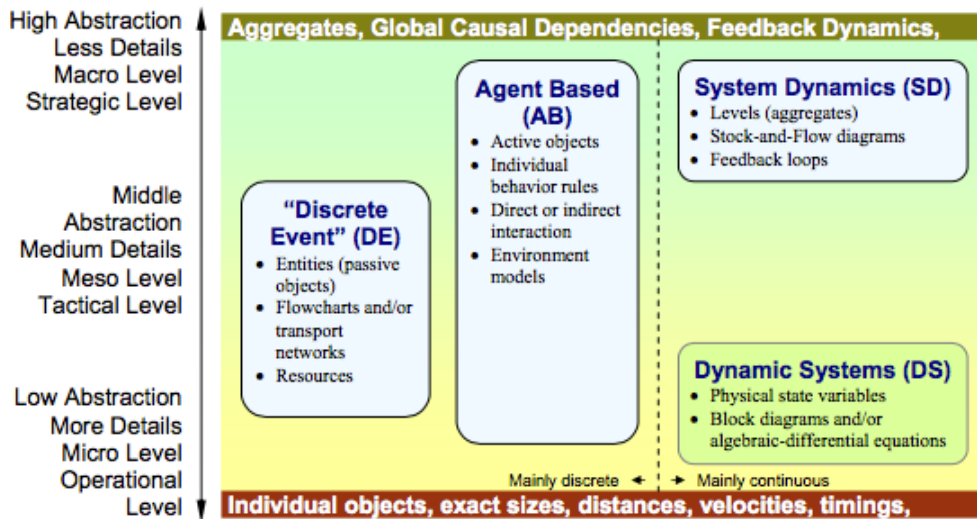
Figure 5: Paradigms in Simulation Modelling on Abstraction Level Scale (Borshchev & Filippov, 2004)

System Dynamics deals with aggregates, therefore, it corresponds to the highest level of abstraction. Discrete Event Simulation deals with entities and flowcharts, so it is used at low to middle level of abstraction. Finally, Agent Based Modelling is used at all abstraction levels, as agents have very diverse nature and scale.

Dynamic Systems (DS) is used to model physical systems, so it will not be studied as it is not relevant for this project.

2.4.2.1 System Dynamics (SD)

The SD approach, Figure 8, is typically used in strategic, long-term simulation models and assumes a high level of aggregation of the modelled objects. People, products, events and other discrete items are represented in SD models by their quantities so they lose any individual properties, histories or dynamics.
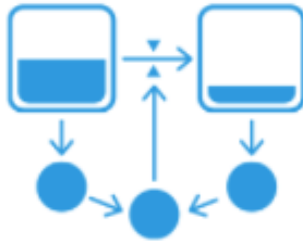
Figure 6: System Dynamics (SD) - (The AnyLogic Company)

SD techniques should be used when its high level of abstraction is appropriate for the problem that will be modelled.

2.4.2.2 Discrete Event Simulation (DES)

DES approximates continuous real-world processes with non-continuous defined events. This technique represents the system as a process, Figure 9, being analysed as a sequence of operations being performed on entities (transactions) that are passive objects that represent people, parts, documents, tasks, vehicles, etc. These processes typically include delays, resources usage, queues, etc. The operations are modelled by their start event and end event, and no changes can take place between any two discrete events.
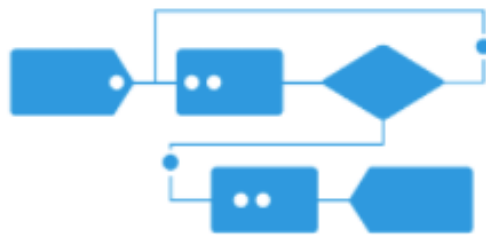
Figure 7: Discrete Event Simulation (DES) – (The AnyLogic Company)

DES techniques should be used only when the system under analysis can naturally be described as a sequence of operations.

2.4.2.3 Agent Based Modelling (ABM)

"ABM describes a system by identifying its actors (agents) and possible interactions between them. The system behaviour then emerges from the

behaviour of the model components and their interactions" (Behdani *et al.*, 2010)

Some of the basic characteristics of any agents include qualities such as (Gavrilova, T.A. and Muromtsev, 2007): activity, autonomy or semi-autonomy, sociability and purpose. Agents used in modelling are very diverse, however, one of the main features of agent based models is that they are decentralized (Serova, 2013). This is, the modeller identifies the active entities, the agents (which can be people, companies, projects, assets, vehicles, cities, animals, ships, products, etc.), defines their behaviour (main drivers, reactions, memory, states, …), puts them in a certain environment and establishes connections, Figure 10. The global behaviour then emerges as a result of interactions of many individual behaviours, which is why it is called bottom-up modelling.
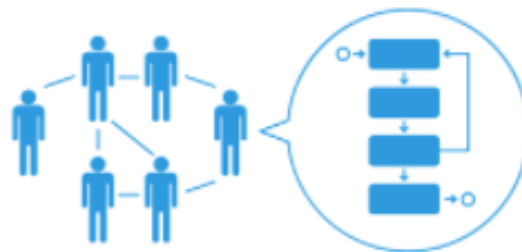
Figure 8: Agent Based Modelling (ABM) - (The AnyLogic Company)

This approach is being widely used in aviation. Wojcik (2004) modelled the Air Traffic Flow Management (ATFM) with ABM, programming the airline agents with different decision-making personalities and interactions with each other in simulated ATFM scenarios. Lewe *et al.* (2011) also employed this approach to generate transportation demand forecasts, focusing on aviation.

2.4.2.4 Correspondences between the paradigms

SD and DES are the traditional approaches, while ABM is relatively new. However, the increasing demand for global business optimization have caused modellers to look at ABM and combined approaches to get deeper insight into complex interdependent processes having different natures (Borshchev & Filippov, 2004).

Traditional modelling approaches treat a company's employees, projects, products, customers and partners as either aggregated averaged quantities or as passive entities or resources in a process. However, they ignore the fact that all those employees, projects, products, customers and partners are all different and have their own histories, intentions, individual properties and complex relationships. The ABM paradigm is free of such limitations as the modeller focus on individual objects in and around the organization, their individual behaviours and their interactions. This paradigm is actually a set of interacting active objects that reflect objects and relationships in the real world and thus is a natural step forward in understanding and managing the complexity of today's business and social systems.

With ABM is it possible to model more real life phenomena than with SD or DES. However, this does not mean that ABM is a replacement for SD or DES. Depending on the application, one approach or another would be more appropriate to efficiently solve the problem. Still, the real power is in mixing two or more approaches to benefit from the best of all of them.

3 METHODOLOGY

The aim of the thesis is to build a model that generates datasets for training business data analysts. Hence, the first objective of the thesis is an extensive literature review to identify current practices in data generation and simulation and to understand the foundations of good quality datasets, data analysts training and enterprise modelling.

Then, a case study will be presented, Longtau Technology enterprise. The characteristics of this fictitious company, as well as its main processes and departments will be defined.

With the findings of the literature review, a model that simulates the interactions between the call centre, sales and technical support departments of Longtau Technology will be developed using AnyLogic software. To build the model, both DES and ABM approaches will be used. To do so, the inputs, outputs and model functioning will be defined before its implementation.

Once the model has been built, the model interfaces will be added. A dashboard (Excel) will be created to control the inputs of the model, as well as an interface to generate the datasets (Excel and Matlab). These interfaces will allow the user to adapt and customise the generated datasets, changing the company characteristics and complexity.

Finally, to validate the effectiveness of the model four different scenarios of Longtau Technology will be defined, simulated and validated. BDA techniques will be used to compare the output of the simulation with the input of the model, comparing the trends and features of each scenario.

4 A CASE STUDY: LONGTAU TECHNOLOGY

In this model, a fictitious company – Longtau Technology – will be modelled. Throughout the MSc in Management & Information Systems this company was studied for several modules, including the assignment of the Business Data Analytics module. Hence, to facilitate the generation of datasets needed for this module, the same company has been chosen.

Longtau Technology is a Chinese enterprise that design, manufacture, sell and support computer network equipment. Recently, it has successfully entered the European market using UK as the European headquarters.

The company sells mainly two types of products: network switches to business customers and SOHO routers and repeaters targeted to a home use market, the latter sold through retail and direct channels in the UK.

The customers are divided in four different groups: individuals, wholesalers, network distributors and Longtau teams. Of these types of customers, only the network distributors buy network products, while the rest buy SOHO products.

There are three main function groups inside the company: the call centre, sales department and technical support department. Each function has its departmental information system to support its work.

The call centre department is responsible for answering general calls. If the call is related with a sale order, then the call centre worker will pass the call to the sales department. If the call is about a technical issue, the call handler will pass the call to the technical support department. Otherwise, the call centre will resolve the issue and close the call.

5 THE MODEL

In this section, the different parts of the model implementation will be explained, as well as the characteristics of the company. First, a theoretical overview will detail all aspects to consider when modelling the Longtau Technology company. Then, the implementation part will dive deep in the model developed with the AnyLogic software.

5.1 Model overview

Chapter 4 explained the company that will be modelled, Longtau Technology. Before starting building the model, all the company characteristics must be completely defined.

The company is composed of three individual departments: the call centre, technical support department and sales department. Every department will have their staff with their own working schedule. Also, the productivity may vary for each department.

Regarding customers, there are four different types: individuals, wholesalers, network distributors and Longtau teams. The customer behaviour (order quantity, technical support needed, frequency of calls, etc.) will vary depending on its type.

There are two types of products, SOHO products (SH18, SH20, SH24 and SH24ehk) and network switches products (NN11, NN12, NN17, NN23, NN28, NN41). Each product has its own price.

The normal process of a call is shown in Figure 12. However, there are exceptions. Under normal conditions, the customer will make a call and a call centre staff member will resolve the issue. If the issue is a technical query, the call centre will pass the call to the TS department, and a TS worker will solve the issue. If the issue is a sale order, the call centre will pass the call to the sales department, and a sales worker will make the sale.

Figure 9: Call Process flow

Table 2 shows the issue and resolution map for the Call Centre:

Issue code	Issue	Resolution code	Resolution
ACC	Account query	ACCORD	Check account record
		FIN	Raise finance query
CAN	Cancellation	CANCEL	Cancelled order
		SUB	Substitute with other product
DEAD	Product died	TC	Pass to Technical Support
DEL	Delivery enquiry	DELI	Check delivery record
DOA	Dead on arrival	BSPT	Go through boot script
		RETN	Arrange return

MIS	Missing items	PSPT	Go through packing list
		RETN	Arrange return
ORD	Order query	ORDER	Check order query
		SALES	Pass to Sales team
PAY	Payment query	ACCORD	Check account record
		FIN	Raise finance query
PROD	Product query	PTREE	Go through product selection tree
		TC	Pass to Technical Support
SET	Setup problem	SSPT	Go through setup script
		TC	Pass to Technical Support
UNEX	Unexplained problem	FOLL	Set up follow up action

Table 2: Issue and Resolution map - Call Centre

The issues for the technical support department are two: PROD and USER. When the cause of the call is that the product has a defect or does not work, the issue is PROD; when the cause of the call is that the user does not have the needed knowledge to use the product, the issue will be USER.

As it has been said previously, there are some exceptions to the normal process flow:

- Apart from the sales department, there are web sales that go on 24h
- There are some customers (ebay, Amazon, Alibaba…) that have in house web sales team and do not use the call centre (Longtau teams)
- Network distributors have direct lines to the sales and TS departments, so they do not necessarily need to call the call centre
- Products NN11 and NN12 are withdrawn from the market but still require technical support
- People who make an enquiry and did not buy anything before are not customers yet

Finally, Table 3 presents the model specifications. Some of the company characteristics will be fixed in the AnyLogic model, while others can be chosen from the input interface. For some characteristics, like the working time, several options are predetermined (Choice of scenario sets), whereas for others, like the number of staff members, the user can enter the desired value (Choice of parameters).

Company characteristics	Fixed in Anylogic code	Choice of scenario sets	Choice of parameters
Organisation structure (3 units) – Call Centre, Sales Team, TS Team	Yes		
Call workflow	Yes		
TS workflow	Yes		
Working Day + Time		Yes	
Worker specialisation		Yes	
Workers in each team			Yes – if scenario not chosen
Worker productivity		Yes – organisation pattern	
Team member holiday		Fixed Kate only	
Product type	Yes		
Product ID	Yes		
Product – Customer link			Probability
Customer type	Yes		
Customer ID			Number in each type

Customer call behaviour		Time of call – NN and wholesalers office hours only, others 24/7 Generic caller for general enquiries	Call rate
Sales Channels workflow	Yes		
Order quantity			Distribution - uniform
Issue Map	Yes		
Warranty	Yes		
Product reliability			Probability
Resolution time	Nominal		
Delivery data	2-4 working days on uniform distribution		
Price			Yes
Call generation	Customer initiation parameter, probabilistic use of issues map		
TS call generation	Product * Customer characteristics		
Public Holiday		Part of working day and time	
Output Data Quality – ie generate missing data in output file		Missing data, wrong value	

Table 3: Model specifications

5.2 Implementation in Anylogic

The code of the AnyLogic model will be explained in this section. AnyLogic is a multimethod simulation modelling tool developed by The AnyLogic Company. The decision of using this software was made because it allows the user to use

the different simulation approaches (Discrete Event, System Dynamics and Agent-Based). The Longtau Technology model is based on both Discrete Event and Agent-Based paradigms. The model was developed with the AnyLogic 7.3.2 University version.

5.2.1 Model agents

As it has already been said, the model is a combination of DES and ABM. Hence, the model will have a sequence of events and also agents with its own behaviour. The agents of the model are the following, Figure 10:
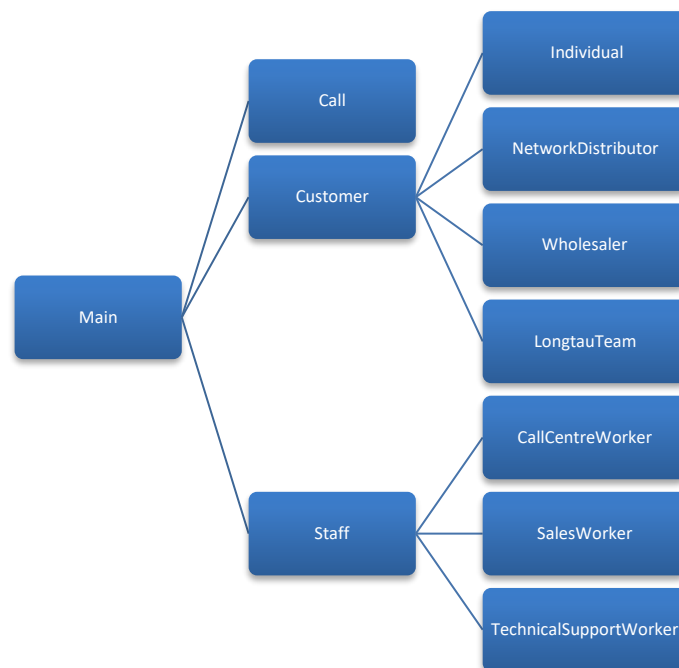
Figure 10: Model agents

Call Agent

The *Call* agent represents each call. This agent has no functions or events, just a parameter called *customer* of type *Customer*. This paremeter is necessary to associate each call to its customer.

Customer Agent

The *Customer* agent has four parameters:

- *type*: this parameter is an Option List with the options: Individual, Wholesaler, NetworkDistributor and LongtauTeam. It represents the type of customer who is making the call
- *queuePatience*: this parameter is a *double* that represents the time the customer will spend at the queue before hanging up
- *orderQuantity*: the type of this parameter is an *int* and it represents the quantity the customer will buy in each order
- *warrantyType*: this parameter is an Option List with the options NS (No Support), LM (Labour and Material only), RMA (Returns Material Authorisation) and 24H (Support within 24h), that represents the warranty type of this customer

The *Customer* agent itself has no function or event, just parameters. However, it has four agents extended: *Individual*, *LongtauTeam*, *NetworkDistributor* and *Wholesalers*, corresponding to the different types of customer.

These four extended agents, besides the four parameters of the *Customer* agent, also have variables, a function, blocks from the Process Modelling Library and a statechart. Figure 11 shows the elements of these agents:
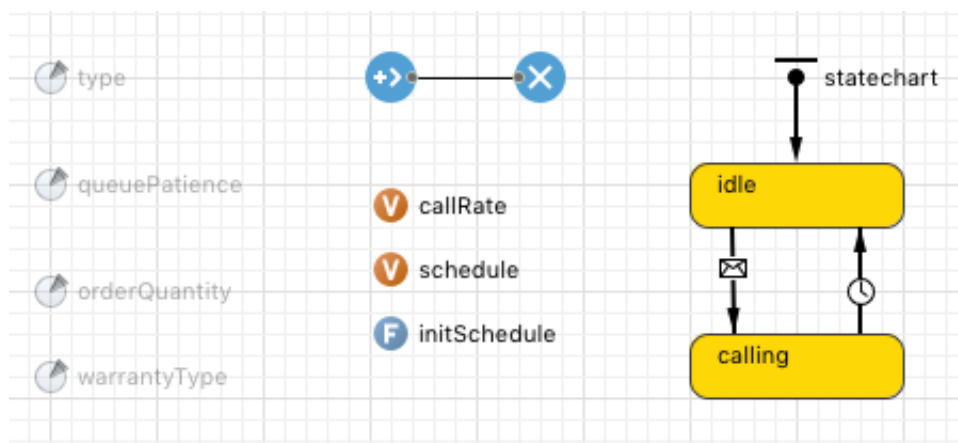
Figure 11: Customer agent attributes

35

The function *initSchedule* is called at the creation of the agent. This function initiates the variable called *schedule* of type *Schedule<Double>* and depending on the configuration of the model (input interface), it creates a schedule with a constant call rate determined by the variable *callRate*, or a schedule with different call rates along the day. Then, this *schedule* is assigned to the *source block*, responsible for generating *Call* agents and send them to the *Main* agent. The customer making the call will be the *customer* parameter of this *Call* agent. Finally, the purpose of the statechart is to avoid that the same customer could make several calls at the same time.

To sum up, this agent – and subagents – are responsible for generating calls. Depending on their parameters, they will generate more or less calls, at the same rate or not. Also, their parameters define their sales order quantity, patience and warranty type. These parameters will be necessary in case the customer places an order or has a technical problem.

Staff Agent

The *Staff* agent only has the parameter *serviceTime*. This parameter's type is *double* and it indicates the time a worker spends doing a job. This agent has three extended agents: *CallCenterWorker*, *SalesWorker* and *TechnicalSupportWorker*. These extended agents represent the different type of workers of the company, and do not have more elements apart from the *serviceTime* parameter.

5.2.2 Main agent

Once all the agents are defined, in the *Main* is where the principal actions occur. The *Main* is composed of several elements like parameters, variables, functions, populations and blocks from the Process Modeling Library, representing the modelled company in a sequence of events (DES).

Figure 12 shows the blocks diagram that represents the company:
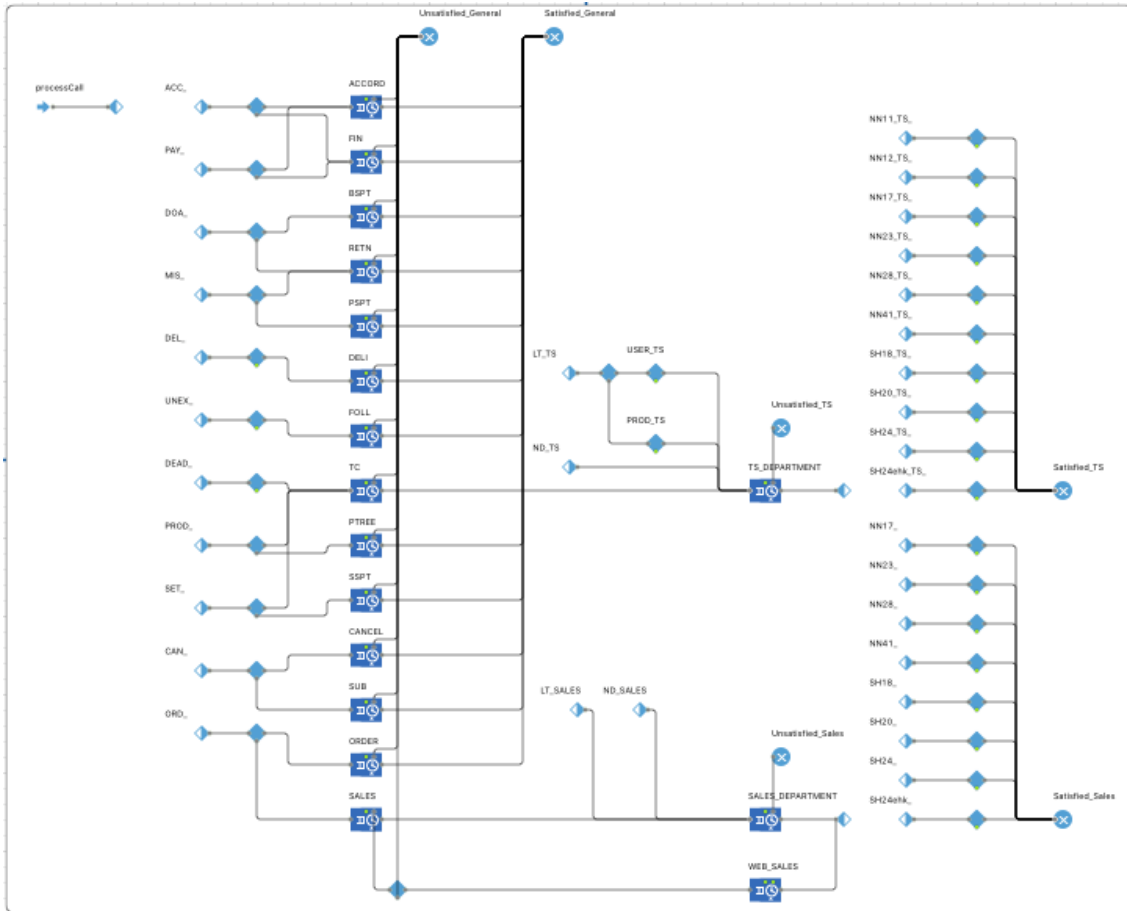
Figure 12: Sequence of events that represent the modelled company

Once the *Call* is generated by the customers, it enters into the system through the *processCall* Enter. Based on probabilities (input interface), the *Call* is classified according to its issue (ACC, PAY, DOA, MIS, DEL, UNEX, DEAD, PROD, SET, CAN and ORD) with the SelectOutputIn and SelectOutputOut blocks. Then, depending again on probabilities a resolution is given to the *Call*.

Once the *Call* has been classified, it enters into a Service block. The Service block seizes a call centre worker from its Resource Pool, delays the *Call* and releases the seized unit, simulating the Call being handled by the call centre worker with its service time. If the call centre staff are occupied and the customer has to wait more time than their established queue time, the customer will hang up and the *Call* will go to the *Unsatisfied_General* Sink. If the Call has been answered successfully, it will go to the *Satisfied_General* Sink.

If the call resolution is TC, after the *TC* Service block the *Call* goes to the *TS_DEPARTMENT* Service. This block seizes a TS engineer from its Resource Pool and assigns a delay, simulating the call being handled by the TS department. As with the call centre, if the customer is kept waiting in the *Service* queue for more time than its queue time, the customer will hang up and the *Call* will go to the *Unsatisfied_TS* Sink. Otherwise, based on probabilities again, an item is assigned to the TS issue and the *Call* will go to the *Satisfied_TS* Sink.

In a similar way, if the call resolution is SALES, after the *SALES* Service Block the *Call* goes to the *SALES_DEPARTMENT* Service. This block seizes a sales worker and assigns a delay, simulating the customer making the order. Again, if the customer is kept waiting for more time than its established queue time, the customer will hang up and the *Call* will go to the *Unsatisfied_Sales* Sink. Otherwise, based on probabilities, an item is assigned to the sales order and the *Call* will go to the *Satisfied_Sales* Sink.

When customers hang up the *Sales* Service because they had been waiting for too long, some of them will go to the *WEB_SALES* Service. This block simulates customers placing orders through the web, without needing a staff member.

Finally, some customers (Longtau Teams and Network Distributors) can have access to direct channels of the TS department and the Sales department. Hence, different exits to the first SelectOutputIn (after *processCall* Enter) have been added (*LT_TS, ND_TS, LT_SALES, ND_SALES*) and go directly to the *TS_DEPARTMENT* Service or the *SALES_DEPARTMENT* Service, without passing through the call centre.

To create the Resource Pools and the customers who will make the calls, different populations and Resource Pools have been created, Figure 13:

Figure 13: Populations and Resource Pools

Previously, the different customer and staff agent classes had been created. Populations are collections of agents. These agents (populations) are instances of the user-defined agent type and if there are parameters defined in this agent type, the default values of these parameters can be changed for these specific agents (population). Therefore, the default value of the parameters of the *Customer* agent can be edited for the *individuals, wholesalers, networkDistributors* and *longtauTeams* populations. The same logic applies to the *Staff* agent parameters with the *callCenterWorkers, salesWorkers* and *technicalSupportWorkers* populations.

To assign units to the Service blocks, Resource Pools are needed. These Resource Pools contain a number of units of a population (*callCenterWorkers, salesWorkers* or *technicalSupportWorkers*). Depending on the configuration chosen by the user, some of these Resource Pools will be empty.

Finally, Figure 14 shows the different parameters and variables used in the model:

Figure 14: Model Parameters and Variables

These variables are divided in four groups: Product Preference, Technical Support needed, Customer behaviour and Worker behaviour. They are used when programing the model:

- **Product Preference** variables are used to define the probabilities of the SelectOutput placed after the *SALES_DEPARTMENT* Service that establishes the item of the sales order.

- **Technical Support needed** variables are used to define the probabilities of the SelectOutput placed after the *TS_DEPARTMENT* Service that stablishes the item of the TS issue.

- **Customer behaviour** variables determine the size of the different populations of customesr, as well as their patience time, the quantity of items they place in each sales order and the frequency of the calls they make. Also, some of these variables (*patienceDistribution, orderQuantityDistribution* and *callScheduleDecision*) change the model code to add more distributions and increase its complexity. With these variables, the customer populations are configured.

- **Worker behaviour** variables define the number of workers in each department (call centre, TS and Sales department), their schedule, if some workers are specialized in some products or not and if their productivity is the same. With these variables, the staff populations are configured.

With these variables the user can customise the model for each scenario, using the Input Interface explained in the next section. This choice of variables has been made taking into account the model specifications of Table 3.

6 Dataset Generation

After describing the Anylogic model, this section explains the input and output interfaces of the model. Furthermore, a user guide has been written to guide the user through all the steps needed to properly generate datasets.

6.1 Interfaces

6.1.1 Input interface

The input interface function is to allow the instructor to configure and customise the model to each trainee. It is an Excel file called "InputExcel.xlsx", Figure 15, where the user can introduce the value of the parameters of the model.

CUSTOMER BEHAVIOUR

Number of customers	
Individuals	2000
Wholesalers	20
Network Distributors	35
Longtau Teams	5

Customers Patience	
Individuals	5
Wholesalers	6
Network Distributors	5
Longtau Teams	1000
Probability distribution?	0

Customers Order Quantity	
Individuals	1
Wholesalers	3500
Network Distributors	125
Longtau Teams	3400
Probability distribution?	0

Customers Monthly Call Rate	
Individuals	5
Wholesalers	40
Network Distributors	35
Longtau Teams	40
Probability distribution?	0

Product Preference	NN17	NN23	NN28	NN41	SH18	SH20	SH24	SH24chk
Individuals	0	0	0	0	0.2466	0.2466	0.2466	0.2603
Wholesalers	0	0	0	0	0.0714	0.2143	0.2857	0.4286
Network Distributors	0.0476	0.2857	0.381	0.3333	0	0	0	0
Longtau Teams	0	0	0	0	0.1667	0.3333	0.2222	0.2778

Technical Support needed	NN11	NN12	NN17	NN23	NN28	NN41	SH18	SH20	SH24	SH24chk
Individuals	0	0	0	0	0	0	0.25	0.2417	0.2417	0.2667
Wholesalers	0	0	0	0	0	0	0.0476	0.1905	0.2857	0.4762
Network Distributors	0.2917	0.2917	0.0417	0.125	0.0833	0.1667	0	0	0	0
Longtau Teams	0	0	0	0	0	0	0.25	0.25	0.25	0.25

WORKER BEHAVIOUR

Number of workers	
Call Center	6
Sales Department	3
TS Department	2

Product specialization of workers	
Sales Department: Michael and Kate do NN and Tony SH	1
TS Department: Xiaoping does NN and Gary SH	1

Workers schedule	
MON-FRI, 9.00-17.00 (0) / MON-SAT, 9.00-14.00 / 16.00-19.00 (1)	0
One Call Center worker works weekends and bank holidays	0
Kate has holidays from 8May-12May	0

Workers productivity	
Different productivity	0

PRODUCT BEHAVIOUR

	NN17	NN23	NN28	NN41	SH18	SH20	SH24	SH24chk
Price	240	1200	850	1075	40	40	60	80

DATASET CHARACTERISTICS

Data Quality	HIGH

Figure 15: Input interface

The input interface is divided in four sections:

- **Customer behaviour**

  In this section, the user will introduce the value of the parameters that will determine the customer behaviour. These parameters are: number of

customers, customers' patience, order quantity, monthly call rate, product preference and technical support needed.

When the probability distribution of a parameter is "0", the values of the parameter are constant during the simulation. If the value is "1", the parameters values follow a distribution during the simulation.

- **Worker behaviour**

  Here the user will define the worker behaviour. First, the user should introduce the number of workers. Then, different scenarios can be chosen regarding the product specialisation of some workers, different working schedules, and whether all workers have the same productivity.

- **Product behaviour**

  In this section the price of the items is set.

- **Quality**

  Here the instructor can define the data quality of the dataset. There are three options available:

  1. HIGH: all data is shown correctly
  2. MEDIUM: some data (2%) is missed in the "customer id" column of the Call Centre record
  3. LOW: some data (5%) is missed in the "customer id" column of the Call Centre record and some errors are introduced in the dataset

6.1.2 Output interface

After running the simulation, several Excel files are saved using the "Log to database" option in AnyLogic with all the relevant data. These files have all the necessary information but are saved in an unstructured form, so it is necessary to configure the data in a easier friendly form for the trainee.

Therefore, a Matlab program has been developed to rearrange the obtained information in a new Excel file with the desired structure. This program reads all files extracted with the simulation and create a new and single Excel file with

three different sheets: Call Centre Log, Sales record and TS record. These sheets contain the parameters shown in Figure 16:

Call Centre Log	Sales record	TS record
• Call record number • Call date • Call time • End call time • Customer number • Call handler • Issue • Resolution • Closed at call	• Sales order number • Customer number • Date • Items • Quantity • Price • Warranty terms • Delivery • Sales staff	• Support call number • Call date • Call time • Customer number • Item • TS engineer • Issue • Resolved

Figure 16: Output file structure

This Excel file is the one the trainee will analyse to extract the findings the user introduced in the configuration.

6.2 User guide

The steps the user has to follow to generate datasets are the following:

1. Create a folder containing:

    - AnyLogic model folder LTmodel_V14 with "LTmodel_V14.alp"

    - Input Interface "InputExcel.xlsx"

    - Matlab code "readExcel.m"

    - Empty Excel file called "AnylogicOutput.xlsx"

    - Empty Excel file called "ExcelOutput.xlsx"

2. Open the Input interface file and introduce the desired values. Saved it and close it.

3. Open the AnyLogic model.

4. In the model, select the "Build model" icon. Then, click the arrow of the "Run LTmodel_V14 / Simulation" icon and select "LTmodel_V14 / InputExcel" (Figure 17):
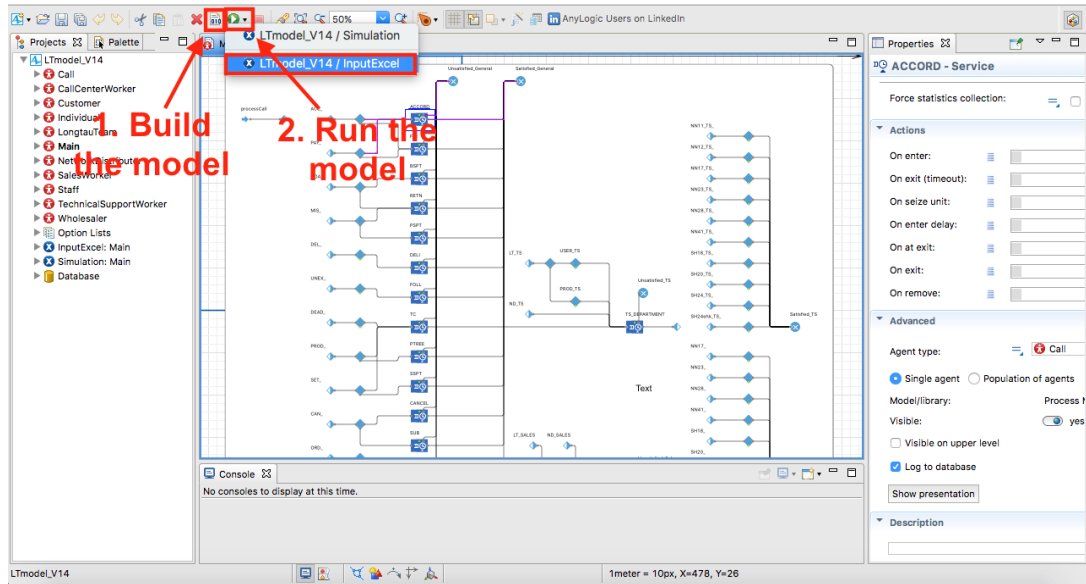
Figure 17: Steps to run the model

5. Once the simulation has finished, close AnyLogic. The Excel file "AnylogicOutput.xlsx" will be written.
6. Open the "readExcel.m" Matlab file and run it. When it has finished, close Matlab. The Excel file "ExcelOutput.xlsx" will be written.
7. The Excel file "ExcelOutput.xlsx" is the generated dataset to train business data analysts.

7 SCENARIO SIMULATION

In this chapter, four different scenarios will be generated and validated with BDA techniques. The first scenario will be the default scenario, and the other proposed scenarios will be compared to this one.

Table 4 shows the parameters that will be changed in each scenario. If all parameters are changed at the same time, the complexity of the model will be so high that it would not be possible to analyse and validate the introduced changes. For that reason, only some parameters are chosen for each scenario; in Scenario 2 the staff behaviour is modified, in Scenario 3 the customer behaviour is changed and in Scenario 4 the quality of the dataset will be low. In this way, it will be possible to detect the changes and new trends of the datasets.

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Working Day and Time		■		
Holidays		■		
Productivity		■		
Order quantity			■	
Product – Customer link			■	
Product reliability			■	
Output Data Quality				■

Table 4: Scenarios definition

Appendix A presents an extract of the datasets generated with each scenario. These extracts correspond to the 2nd May 2017.

7.1 Scenario 1

For the first scenario, the input values that determine the company characteristics are shown in Figure 18:

CUSTOMER BEHAVIOUR

Number of customers	
Individuals	2000
Wholesalers	20
Network Distributors	35
Longtau Teams	5

Customers Patience	
Individuals	5
Wholesalers	6
Network Distributors	5
Longtau Teams	1000
Probability distribution?	0

Customers Order Quantity	
Individuals	1
Wholesalers	3500
Network Distributors	125
Longtau Teams	3400
Probability distribution?	0

Customers Monthly Call Rate	
Individuals	5
Wholesalers	40
Network Distributors	35
Longtau Teams	40
Probability distribution?	0

Product Preference	NN17	NN23	NN28	NN41	SH18	SH20	SH24	SH24ehk
Individuals	0	0	0	0	0.2466	0.2466	0.2466	0.2603
Wholesalers	0	0	0	0	0.0714	0.2143	0.2857	0.4286
Network Distributors	0.0476	0.2857	0.381	0.3333	0	0	0	0
Longtau Teams	0	0	0	0	0.1667	0.3333	0.2222	0.2778

Technical Support needed	NN11	NN12	NN17	NN23	NN28	NN41	SH18	SH20	SH24	SH24ehk
Individuals	0	0	0	0	0	0	0.25	0.2417	0.2417	0.2667
Wholesalers	0	0	0	0	0	0	0.0476	0.1905	0.2857	0.4762
Network Distributors	0.2917	0.2917	0.0417	0.125	0.0833	0.1667	0	0	0	0
Longtau Teams	0	0	0	0	0	0	0.25	0.25	0.25	0.25

WORKER BEHAVIOUR

Number of workers	
Call Center	6
Sales Department	3
TS Department	2

Product specialization of workers	
Sales Department: Michael and Kate do NN and Tony SH	1
TS Department: Xiaoping does NN and Gary SH	1

Workers schedule	
MON-FRI, 9.00-17.00 (0) MON-SAT, 9.00-14.00 / 16.00-19.00 (1)	0
One Call Center worker works weekends and bank holidays	0
Kate has holidays from 8May-12May	0

Workers productivity	
Different productivity	0

PRODUCT BEHAVIOUR

	NN17	NN23	NN28	NN41	SH18	SH20	SH24	SH24ehk
Price	240	1200	850	1075	40	40	60	80

Figure 18: Scenario 1 Input Values

After making an exhaust analysis of the data with BDA techniques presented in Appendix B, here are the most significant findings for the validation:

- The number of customers per customer type is the same as the input values
- Fixed order quantity per customer type as the cell of the probability distribution of this parameter is not selected
- Different average call rate per customer, depending on the customer type
- Product preference per customer as entered in the input Excel (eg. Network Distributors only buy NN products)

- The number of workers per department is the same as the input values

- Sales and TS staff are specialized in some products

- Working times are MON to FRI, 9.00-17.00

- High data quality, no blank spaces apart from the "customer id" of the persons who made an enquiry but did not buy anything yet

7.2 Scenario 2

For the second scenario, the input values related to the worker behaviour parameters are modified, Figure 19. The rest of the parameters are kept constant.

WORKER BEHAVIOUR							
Number of workers		**Product specialization of workers**		**Workers schedule**		**Workers productivity**	
Call Center	6	Sales Department: Michael and Kate do NN and Tony SH	1	MON-FRI, 9.00-17.00 (0) MON-SAT, 9.00-14.00 / 16.00-19.00 (1)	1	Different productivity	1
Sales Department	3	TS Department: Xiaoping does NN and Gary SH	1	One Call Center worker works weekends and bank holidays	0		
TS Department	2			Kate has holidays from 8May-12May	1		

Figure 19: Scenario 2 Input Values

To validate it, an analysis of the data will be made to validate the changes regarding Scenario 1.

Figure 20 shows the call distribution of the call centre along the 2nd May 2017. It can be seen that now calls are processed between 9.00-14.00 and 16.00-19.00. Therefore, the working hours have changed. The sales staff and TS staff also have the new timetable; however, this cannot be seen from the data as there are no information available about the call times for these departments.
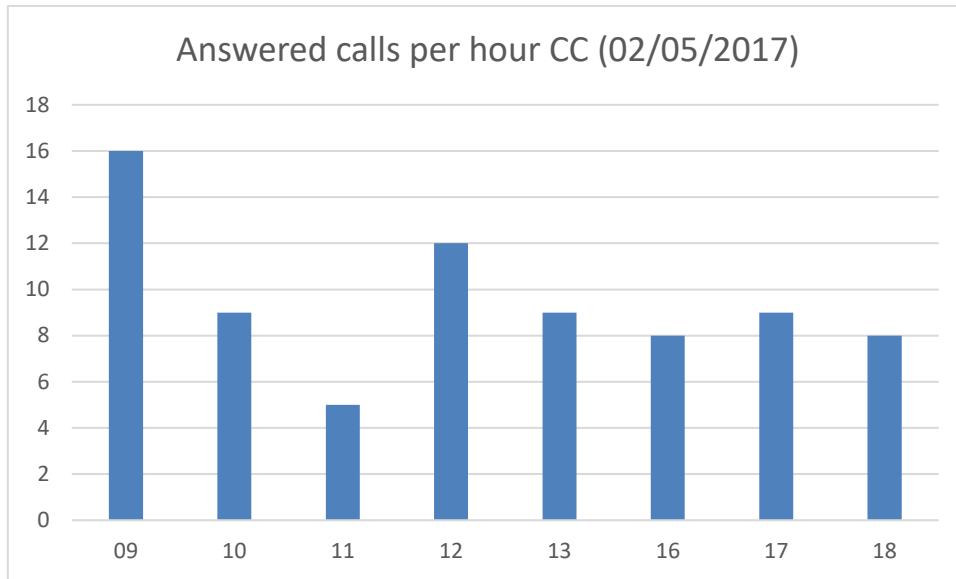
Figure 20: Distribution of call along the day CC

Figure 21 presents the sales orders processed per team worker. Looking at the data, worker 18623 (Kate) does not take any order from the 6th May until the 15th May. This verifies that she was on holidays during the period between the 8th -12th May.
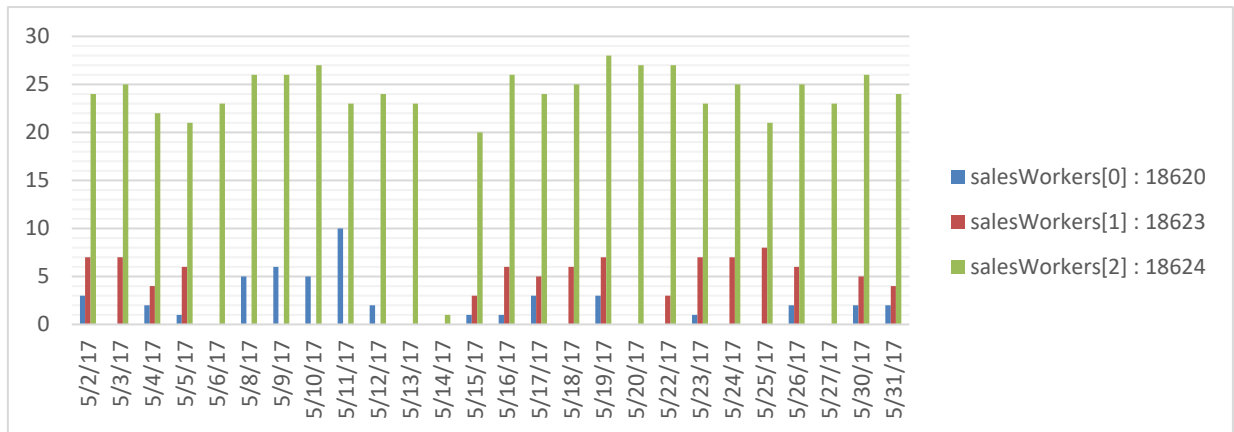
Figure 21: Sales orders per day and worker

7.3 Scenario 3

For the Scenario 3, the input values corresponding to the customer behaviour have been modified, Figure 22. The rest of the parameters are kept constant from the default scenario, Scenario 1.

Figure 22: Scenario 3 Input Values

Again, in order to validate it, an analysis of the data will be made to verify the changes regarding Scenario 1.

Figure 23 and Figure 24 present the sold quantity per item for Scenario 1 and Scenario 3, respectively. It can be seen that in Scenario 3, sales are more distributed between the different items than in Scenario 1. This is because now all customers have the same probability to buy each item, 0.125 (now Network Distributors also buy SOHO products). Furthermore, the customer's order quantities have changed and in Scenario 3 not all customers order the same exact quantity of items per order (probability distribution is selected).
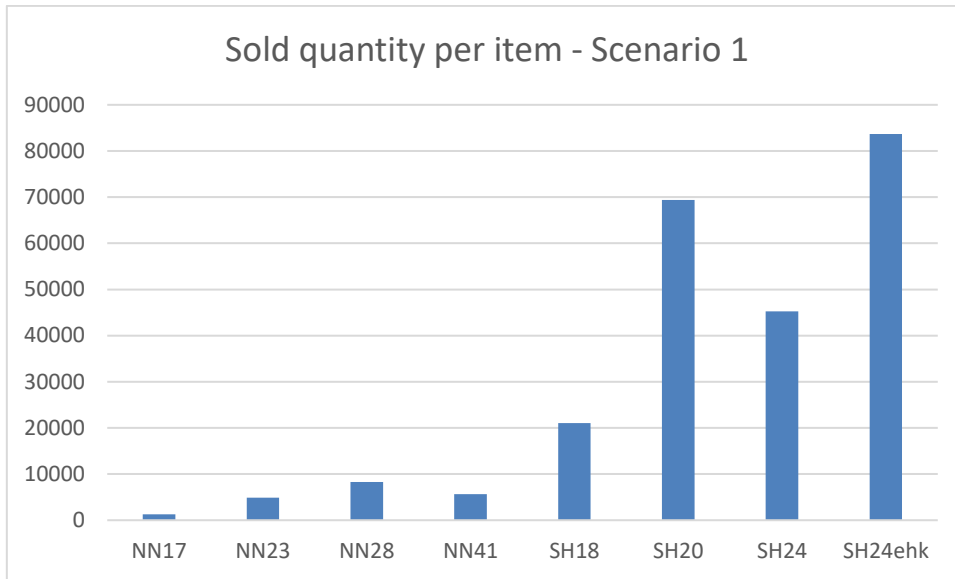
Figure 23: Sold quantity per item - Scenario 1
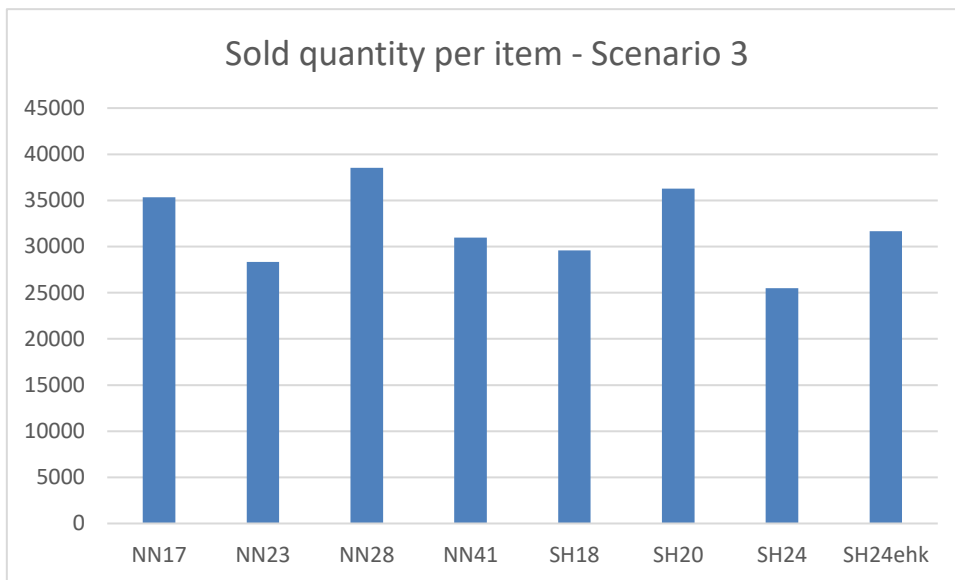
Figure 24: Sold quantity per item - Scenario 3

In a similar way, the percentage of needed technical support has also changed, and all items request the same help, Figure 25.
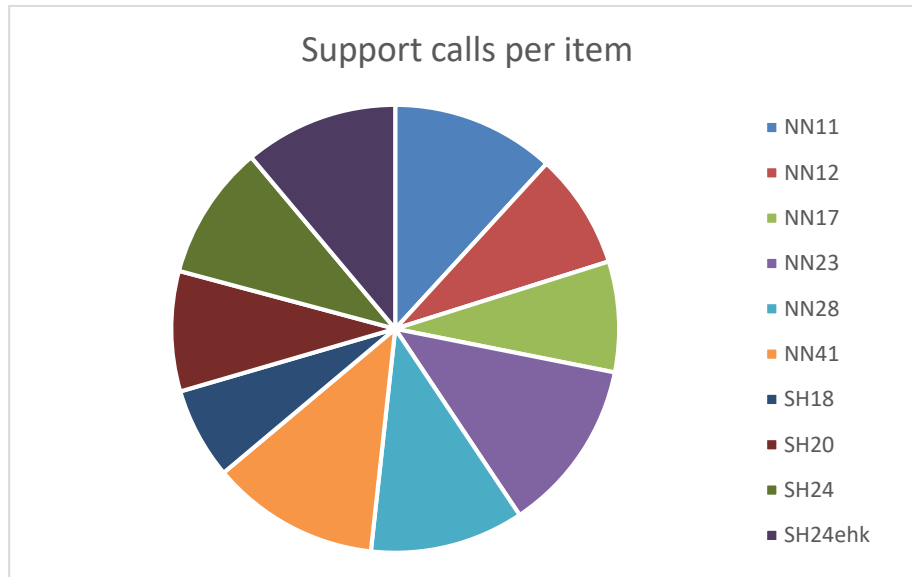
Figure 25: Support calls per item

7.4 Scenario 4

In Scenario 4, all the model parameters have the same value as in Scenario 1 but the data quality. In the previous scenarios, data quality was set high. However, in Scenario 4 the data quality input is low.

Low quality data has been stablished as having 5% of blank cells in the Call Centre Login the "customer id", "issues" and "resolutions" columns. Besides, some incoherent values have been entered into the data:

- Network Distributors also buy SOHO products. This is an error as in the inputs of the product preference, they only buy NN products.
- For the warranty terms, individuals' customers have 24H warranty type.

Both the blanks and the intentional errors can be seen directly in the extract of the dataset in Appendix A.

8 DISCUSSION

This project main output is the development of a simulation tool that generates dynamic datasets to support business data analysts training.

To obtain the data, a model simulating the interaction between the main departments – call centre, sales and technical support - of a fictitious company (Longtau Technology) has been built using Anylogic. Anylogic software has been chosen due to its capability of multimethod simulation modelling and its user friendly interface. However, the output from the Anylogic model does not have the desired structure for the purpose of this project. Hence, a Matlab program has been developed to trace the calls and arrange the data in a similar way to CRM and ERP records.

So far, there are no evidence or public research in simulation tools created with this purpose. Nevertheless, the use of this tool to create datasets to support data analysts training will bring undeniable benefits:

- Firstly, the amount of time needed to create the dataset is substantially reduced. With this tool, the instructor will not have to create the data manually or capture real trading data from companies, which usually is confidential. Furthermore, the simulation of the model and consecutive generation of the dataset normally takes less than 5 minutes.
- Secondly, the user can control and customise the company attributes with the input interface. This means that the instructor will be able to adapt the model complexity to the trainee skills levels.

Although there are previous research in simulation-based training (Zook, Lee Urban, et al., 2012) and the method of scenario generation of Luo et al. (2008) has been adopted, this thesis is innovative in several ways:

- The model is a combination of DES and ABM, taking into account not only the process flowchart but also the individual behaviour of the agents (customers and staff).
- The user input interface allows the instructor to define the company characteristics, with a choice of scenario sets and parameters. This

allows the instructor to rapidly create different dataset for their trainees, being able to show the same trends (or not) but with different values.

- The user can define the quality dataset. When the trainee has a high skill levels, the difficulty of the training can be adapted by introducing errors and blank spaces to the dataset.

8.1 Limitations

During the development of this project, several limitations have been encountered.

Firstly, when building the model with AnyLogic many company characteristics had to be fixed in the code, like the flow of the calls. Therefore, there is a limitation in the model customisation.

Secondly, the output data from AnyLogic is difficult to interpret and analyse. When extracting the data from the model, the data is presented in different Excel files showing different characteristics each. Therefore, it is extremely difficult for the trainee to trace the calls from all the different files.

Finally, with AnyLogic is not possible to directly create a dashboard with the inputs of the model. Therefore, the user will have to fill and save an Excel file to configure the model. In a similar way, after the model has been run, the user will have to run the Matlab program to generate the final dataset.

9 CONCLUSIONS

Based on the literature review and considering the desired output from the project, a simulation tool has been developed to generate dynamic datasets to support business data analysts training.

First of all, a business case has been proposed. A fictitious company, Longtau Technology, has been described in terms of its products and services, departments, staff and customers.

Then, the model of this company has been built using AnyLogic software. The model has been developed using a combination of two modelling approaches; Discrete Event Simulation and Agent Base Modelling. Therefore, not only the model takes into account the sequence of operations (flowchart), but also the behaviour of the agents (customers and staff).

To allow the instructor to configure and adapt the model to the trainee skill levels, an input interface has been created. This interface is an Excel file where the user can enter the desired values for the parameters that define the customer behaviour, worker behaviour, product behaviour and quality of the dataset. Furthermore, an output interface (Matlab program) has been created to give structure to the model output and present the data in a similar way to CRM or ERP reports. Hence, the thesis aim is achieved and the simulation tool generates dynamic datasets to support the training of data analysts.

Finally, the tool has been validated with the simulation of four different scenarios. These scenarios presented different customer behaviour, staff behaviour or data quality. The data generated with each scenario has been validated using BDA techniques.

To conclude, the achievement of the thesis objectives will be evaluated. The objectives of this project were:

- Model Longtau Technology company using AnyLogic software
- Create a user interface to enter the company attributes and dataset complexity as inputs

- Generate dataset in Excel file
- Define and validate three different scenarios for Longtau Technology

All these objectives have been successfully achieved. Furthermore, the simulation tool was validated in a more extensive way than planned, as more scenarios were defined and validated. Finally, the format of the generated dataset has also been improved, giving it the structure of CRM or ERP records and making it more realistic and similar to the data the trainee will work with in the real world.

9.1 Future recommendation

For further work on this project, some recommendations are proposed:

- To include more parameters in the input interface so that the user can fully define the company attributes and characteristics
- To define and model a more complex company with more departments so that more data from the departments interactions can be extracted and the complexity of the datasets can be increased
- To model different types of companies from different industries. Depending on the trainee sector, a similar company to their real company can be chosen to generate datasets from
- Study the possibility of translating the model and interfaces to Java code, so that the whole model can be executed together without the necessity of opening Excel, AnyLogic and Matlab

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APPENDICES

Appendix A Datasets

A.1 Dataset Scenario 1

A.1.1 Call Centre Log

CALL RECORD NUMBER	CALL DATE	CALL TIME	END CALL TIME	CUSTOMER NUMBER	CALL HANDLER	ISSUE	RESOLUTION	CLOSED AT CALL
18583	02/05/2017	9:05:46	9:15:46	individuals[1008]	callCenterWorkers[1] : 18570	ORD	SALES	Yes
18585	02/05/2017	9:21:22	9:31:22	individuals[815]	callCenterWorkers[2] : 18571	DOA	BSPT	Yes
18581	02/05/2017	9:04:50	9:14:50	individuals[346]	callCenterWorkers[0] : 18569	DEAD	TC	Yes
18591	02/05/2017	9:32:38	9:42:38	individuals[455]	callCenterWorkers[5] : 18574	PAY	FIN	Yes
18587	02/05/2017	9:22:05	9:32:05	individuals[1777]	callCenterWorkers[3] : 18572	ORD	SALES	Yes
18595	02/05/2017	9:44:15	9:54:15	individuals[500]	callCenterWorkers[1] : 18570	ORD	ORDER	Yes
18605	02/05/2017	9:51:24	10:01:24	individuals[1198]	callCenterWorkers[0] : 18569	DEL	DELI	Yes
18593	02/05/2017	9:36:55	9:46:55	networkDistributors[25]	callCenterWorkers[0] : 18569	ORD	SALES	Yes
18589	02/05/2017	9:32:37	9:42:37	networkDistributors[14]	callCenterWorkers[4] : 18573	PROD	TC	Yes
18607	02/05/2017	9:52:54	9:54:15	individuals[276]	callCenterWorkers[1] : 18570	ORD	ORDER	Yes
18597	02/05/2017	9:46:43	9:56:43	individuals[1916]	callCenterWorkers[2] : 18571	ORD	SALES	Yes
18613	02/05/2017	10:04:29	10:14:29	individuals[1589]	callCenterWorkers[4] : 18573	ACC	FIN	Yes
18599	02/05/2017	9:47:18	9:57:18		callCenterWorkers[3] : 18572	PROD	TC	Yes
18615	02/05/2017	10:08:22	10:18:22	individuals[833]	callCenterWorkers[5] : 18574	PAY	FIN	Yes
18621	02/05/2017	10:15:01	10:25:01	individuals[1768]	callCenterWorkers[2] : 18571	PAY	ACCORD	Yes
18611	02/05/2017	9:59:28	10:09:28	individuals[234]	callCenterWorkers[3] : 18572	ORD	SALES	Yes
18617	02/05/2017	10:08:29	10:18:29	individuals[1450]	callCenterWorkers[0] : 18569	SET	TC	Yes
18625	02/05/2017	10:29:12	10:39:12	wholesalers[8]	callCenterWorkers[4] : 18573	MIS	PSPT	Yes
18629	02/05/2017	10:35:32	10:45:32	individuals[1481]	callCenterWorkers[0] : 18569	ACC	FIN	Yes
18623	02/05/2017	10:26:49	10:36:49	individuals[542]	callCenterWorkers[3] : 18572	ORD	SALES	Yes
18633	02/05/2017	10:47:33	10:57:33	individuals[1688]	callCenterWorkers[2] : 18571	DEL	DELI	Yes
18635	02/05/2017	10:48:06	10:58:06	individuals[219]	callCenterWorkers[3] : 18572	UNEX	FOLL	Yes
18641	02/05/2017	10:55:51	11:05:51	individuals[843]	callCenterWorkers[0] : 18569	PAY	FIN	Yes
18631	02/05/2017	10:40:57	10:50:57	individuals[480]	callCenterWorkers[1] : 18570	SET	TC	Yes
18637	02/05/2017	10:49:09	10:59:09	individuals[1841]	callCenterWorkers[4] :	ORD	SALES	Yes

					18573			
18649	02/05/2017	11:04:45	11:14:45	individuals[174]	callCenterWorkers[4] : 18573	DOA	BSPT	Yes
18643	02/05/2017	11:01:38	11:11:38	individuals[1456]	callCenterWorkers[1] : 18570	ORD	SALES	Yes
18657	02/05/2017	11:19:50	11:29:50	individuals[1172]	callCenterWorkers[2] : 18571	ORD	ORDER	Yes
18659	02/05/2017	11:20:45	11:30:45		callCenterWorkers[3] : 18572	UNEX	FOLL	Yes
18645	02/05/2017	11:03:53	11:13:53	individuals[265]	callCenterWorkers[2] : 18571	DEAD	TC	Yes
18663	02/05/2017	11:29:19	11:39:19	individuals[1908]	callCenterWorkers[5] : 18574	PAY	FIN	Yes
18665	02/05/2017	11:33:49	11:43:49		callCenterWorkers[0] : 18569	UNEX	FOLL	Yes
18655	02/05/2017	11:18:11	11:28:11	individuals[637]	callCenterWorkers[1] : 18570	ORD	SALES	Yes
18661	02/05/2017	11:21:59	11:31:59	wholesalers[2]	callCenterWorkers[4] : 18573	DEAD	TC	Yes
18675	02/05/2017	11:53:02	12:03:02	individuals[120]	callCenterWorkers[4] : 18573	ACC	FIN	Yes
18679	02/05/2017	11:54:47	12:04:47	individuals[1070]	callCenterWorkers[0] : 18569	DEL	DELI	Yes
18669	02/05/2017	11:39:57	11:49:57	individuals[1909]	callCenterWorkers[1] : 18570	ORD	SALES	Yes
18671	02/05/2017	11:42:03	11:52:03	individuals[710]	callCenterWorkers[2] : 18571	SET	TC	Yes
18677	02/05/2017	11:53:49	12:03:49	individuals[1494]	callCenterWorkers[5] : 18574	ORD	SALES	Yes
18684	02/05/2017	12:21:01	12:31:01	individuals[92]	callCenterWorkers[2] : 18571	ACC	ACCORD	Yes
18686	02/05/2017	12:21:16	12:31:16	individuals[738]	callCenterWorkers[3] : 18572	DEL	DELI	Yes
18690	02/05/2017	12:22:12	12:32:12	individuals[309]	callCenterWorkers[5] : 18574	PAY	ACCORD	Yes
18682	02/05/2017	12:07:10	12:17:10	individuals[1199]	callCenterWorkers[1] : 18570	DEAD	TC	Yes
18694	02/05/2017	12:34:22	12:44:22	networkDistributors[0]	callCenterWorkers[1] : 18570	DEL	DELI	Yes
18696	02/05/2017	12:34:26	12:44:26	networkDistributors[22]	callCenterWorkers[2] : 18571	PAY	FIN	Yes
18698	02/05/2017	12:34:28	12:44:28	wholesalers[7]	callCenterWorkers[3] : 18572	PAY	FIN	Yes
18688	02/05/2017	12:21:16	12:31:16	individuals[1691]	callCenterWorkers[4] : 18573	ORD	SALES	Yes
18700	02/05/2017	12:39:30	12:49:30	individuals[1694]	callCenterWorkers[4] : 18573	MIS	RETN	Yes
18704	02/05/2017	12:46:14	12:56:14	individuals[1418]	callCenterWorkers[0] : 18569	ORD	ORDER	Yes
18708	02/05/2017	12:54:37	13:04:37	individuals[1934]	callCenterWorkers[2] : 18571	PAY	FIN	Yes
18710	02/05/2017	13:00:20	13:10:20		callCenterWorkers[3] : 18572	UNEX	FOLL	Yes
18702	02/05/2017	12:45:42	12:55:42	individuals[1143]	callCenterWorkers[5] : 18574	ORD	SALES	Yes
18712	02/05/2017	13:03:24	13:13:24	individuals[1333]	callCenterWorkers[4] : 18573	PAY	FIN	Yes
18716	02/05/2017	13:09:42	13:19:42	networkDistributors[6]	callCenterWorkers[0] : 18569	PAY	ACCORD	Yes
18722	02/05/2017	13:18:19	13:28:19	individuals[1765]	callCenterWorkers[3] : 18572	PAY	FIN	Yes
18714	02/05/2017	13:06:15	13:16:15	individuals[374]	callCenterWorkers[5] :	ORD	SALES	Yes

					18574			
18724	02/05/2017	13:22:19	13:32:19	individuals[1187]	callCenterWorkers[4] : 18573	PAY	FIN	Yes
18718	02/05/2017	13:15:11	13:25:11	networkDistributors[13]	callCenterWorkers[1] : 18570	ORD	SALES	Yes
18729	02/05/2017	13:45:14	13:55:14	individuals[1223]	callCenterWorkers[0] : 18569	UNEX	FOLL	Yes
18731	02/05/2017	13:47:22	13:57:22	individuals[297]	callCenterWorkers[1] : 18570	ACC	ACCORD	Yes
18727	02/05/2017	13:44:25	13:54:25	individuals[1797]	callCenterWorkers[5] : 18574	ORD	SALES	Yes
18737	02/05/2017	13:55:02	14:05:02	individuals[1663]	callCenterWorkers[4] : 18573	ORD	SALES	Yes
18739	02/05/2017	14:01:17	14:11:17	individuals[121]	callCenterWorkers[5] : 18574	DEAD	TC	Yes
18751	02/05/2017	14:24:32	14:34:32	individuals[1849]	callCenterWorkers[5] : 18574	ACC	FIN	Yes
18755	02/05/2017	14:29:05	14:39:05	individuals[1735]	callCenterWorkers[1] : 18570	UNEX	FOLL	Yes
18749	02/05/2017	14:20:41	14:30:41	individuals[866]	callCenterWorkers[4] : 18573	ORD	SALES	Yes
18761	02/05/2017	14:33:31	14:43:31	individuals[1091]	callCenterWorkers[4] : 18573	ORD	SALES	Yes
18759	02/05/2017	14:31:48	14:41:48	individuals[220]	callCenterWorkers[3] : 18572	PROD	TC	Yes
18765	02/05/2017	14:47:32	14:57:32	individuals[1639]	callCenterWorkers[0] : 18569	ORD	SALES	Yes
18769	02/05/2017	14:51:38	15:01:38	individuals[557]	callCenterWorkers[2] : 18571	DEAD	TC	Yes
18777	02/05/2017	15:01:09	15:11:09	individuals[76]	callCenterWorkers[0] : 18569	ORD	SALES	Yes
18789	02/05/2017	15:31:52	15:41:52	individuals[24]	callCenterWorkers[5] : 18574	MIS	PSPT	Yes
18781	02/05/2017	15:21:55	15:31:55	individuals[1543]	callCenterWorkers[2] : 18571	ORD	SALES	Yes
18799	02/05/2017	15:44:57	15:54:57	individuals[87]	callCenterWorkers[4] : 18573	PAY	FIN	Yes
18785	02/05/2017	15:30:26	15:40:26	networkDistributors[15]	callCenterWorkers[3] : 18572	ORD	SALES	Yes
18787	02/05/2017	15:30:29	15:40:29	networkDistributors[24]	callCenterWorkers[4] : 18573	ORD	SALES	Yes
18791	02/05/2017	15:34:39	15:44:39	individuals[243]	callCenterWorkers[0] : 18569	ORD	SALES	Yes
18807	02/05/2017	15:53:20	16:03:20	individuals[1460]	callCenterWorkers[2] : 18571	DEL	DELI	Yes
18811	02/05/2017	15:55:18	16:05:18	wholesalers[4]	callCenterWorkers[4] : 18573	ACC	FIN	Yes
18817	02/05/2017	16:00:28	16:10:28	individuals[1052]	callCenterWorkers[1] : 18570	UNEX	FOLL	Yes
18803	02/05/2017	15:45:35	15:55:35	individuals[726]	callCenterWorkers[0] : 18569	SET	TC	Yes
18821	02/05/2017	16:11:09	16:21:09	individuals[1500]	callCenterWorkers[3] : 18572	DEL	DELI	Yes
18813	02/05/2017	15:56:24	16:06:24	individuals[1267]	callCenterWorkers[5] : 18574	ORD	SALES	Yes
18823	02/05/2017	16:19:26	16:29:26	individuals[401]	callCenterWorkers[4] : 18573	DEL	DELI	Yes
18819	02/05/2017	16:09:29	16:19:29	individuals[954]	callCenterWorkers[2] : 18571	ORD	SALES	Yes
18827	02/05/2017	16:26:28	16:36:28	individuals[752]	callCenterWorkers[0] : 18569	PAY	FIN	Yes
18829	02/05/2017	16:31:51	16:41:51	individuals[1508]	callCenterWorkers[1] :	UNEX	FOLL	Yes

					18570			
18825	02/05/2017	16:24:59	16:34:59	wholesalers[15]	callCenterWorkers[5] : 18574	SET	TC	Yes
18831	02/05/2017	16:37:03	16:47:03	individuals[1780]	callCenterWorkers[2] : 18571	ORD	SALES	Yes
18839	02/05/2017	16:57:50	17:07:50	wholesalers[11]	callCenterWorkers[0] : 18569	PAY	ACCORD	Yes
18833	02/05/2017	16:45:03	16:55:03	networkDistributors[19]	callCenterWorkers[3] : 18572	ORD	SALES	Yes

Table A:1 Call Centre - Log Scenario 1

A.1.2 Sales record

SALES ORDER NUMBER	CUSTOMER NUMBER	DATE	ITEMS	QUANTITY	PRICE	WARRANTY TERMS	DELIVERY	SALES STAFF
5044	individuals[1008]	02/05/2017	SH24	1	60	NS	05/05/2017	salesWorkers[2] : 18579
5045	individuals[1777]	02/05/2017	SH18	1	40	NS	04/05/2017	salesWorkers[2] : 18579
5046	networkDistributors[25]	02/05/2017	NN41	125	Confidential in Commerce	24H	08/05/2017	salesWorkers[1] : 18578
5047	individuals[1916]	02/05/2017	SH20	1	40	NS	05/05/2017	salesWorkers[2] : 18579
5048	individuals[234]	02/05/2017	SH24ehk	1	80	NS	04/05/2017	salesWorkers[2] : 18579
5049	individuals[542]	02/05/2017	SH20	1	40	NS	05/05/2017	salesWorkers[2] : 18579
5050	individuals[1841]	02/05/2017	SH24ehk	1	80	NS	05/05/2017	salesWorkers[2] : 18579
5051	individuals[1456]	02/05/2017	SH20	1	40	NS	05/05/2017	salesWorkers[2] : 18579
5052	individuals[637]	02/05/2017	SH24	1	60	NS	05/05/2017	salesWorkers[2] : 18579
5053	networkDistributors[14]	02/05/2017	NN41	125	Confidential in Commerce	24H	05/05/2017	salesWorkers[1] : 18578
5054	individuals[1909]	02/05/2017	SH20	1	40	NS	05/05/2017	salesWorkers[2] : 18579
5055	individuals[1494]	02/05/2017	SH18	1	40	NS	05/05/2017	salesWorkers[2] : 18579
5056	individuals[1691]	02/05/2017	SH24ehk	1	80	NS	05/05/2017	salesWorkers[2] : 18579
5057	individuals[1143]	02/05/2017	SH18	1	40	NS	08/05/2017	salesWorkers[2] : 18579
5058	individuals[374]	02/05/2017	SH20	1	40	NS	05/05/2017	salesWorkers[2] : 18579
5059	networkDistributors[13]	02/05/2017	NN28	125	Confidential in Commerce	24H	05/05/2017	salesWorkers[1] : 18578
5060	individuals[1797]	02/05/2017	SH24ehk	1	80	NS	08/05/2017	salesWorkers[2] : 18579
5061	individuals[1663]	02/05/2017	SH24ehk	1	80	NS	04/05/2017	salesWorkers[2] : 18579
5062	individuals[866]	02/05/2017	SH20	1	40	NS	04/05/2017	salesWorkers[2] : 18579
5063	individuals[1091]	02/05/2017	SH20	1	40	NS	04/05/2017	salesWorkers[2] : 18579
5064	individuals[1639]	02/05/2017	SH20	1	40	NS	04/05/2017	salesWorkers[2] : 18579

5065	individuals[76]	02/05/2017	SH24ehk	1	80	NS	05/05/2017	salesWorkers[2] : 18579
5066	networkDistributors[9]	02/05/2017	NN28	125	Confidential in Commerce	24H	05/05/2017	salesWorkers[1] : 18578
5067	individuals[1543]	02/05/2017	SH24ehk	1	80	NS	04/05/2017	salesWorkers[2] : 18579
5068	networkDistributors[15]	02/05/2017	NN28	125	Confidential in Commerce	24H	05/05/2017	salesWorkers[0] : 18575
5069	networkDistributors[24]	02/05/2017	NN17	125	Confidential in Commerce	24H	04/05/2017	salesWorkers[1] : 18578
5070	individuals[243]	02/05/2017	SH20	1	40	NS	04/05/2017	salesWorkers[2] : 18579
5071	individuals[1267]	02/05/2017	SH24	1	60	NS	05/05/2017	salesWorkers[2] : 18579
5072	individuals[954]	02/05/2017	SH20	1	40	NS	08/05/2017	salesWorkers[2] : 18579
5073	individuals[1780]	02/05/2017	SH20	1	40	NS	08/05/2017	salesWorkers[2] : 18579
5074	networkDistributors[19]	02/05/2017	NN28	125	Confidential in Commerce	24H	05/05/2017	salesWorkers[1] : 18578

Table A:2 Sales record - Scenario 1

A.1.3 TS record

SUPPORT CALL NUMBER	CALL DATE	CALL TIME	CUSTOMER NUMBER	ITEM	TS ENGINEER	ISSUE	RESOLVED
3300	02/05/2017	9:14:50	individuals[346]	SH24	technicalSupportWorkers[1] : 18577	PROD	Yes
3301	02/05/2017	9:42:37	networkDistributors[14]	NN41	technicalSupportWorkers[0] : 18576	USER	Yes
3302	02/05/2017	9:57:18	individuals[1827]	SH20	technicalSupportWorkers[1] : 18577	USER	Yes
3303	02/05/2017	10:18:29	individuals[1450]	SH20	technicalSupportWorkers[1] : 18577	USER	Yes
3304	02/05/2017	10:50:57	individuals[480]	SH24ehk	technicalSupportWorkers[1] : 18577	USER	Yes
3305	02/05/2017	11:13:53	individuals[265]	SH24ehk	technicalSupportWorkers[1] : 18577	PROD	Yes
3306	02/05/2017	11:31:59	wholesalers[2]	SH24ehk	technicalSupportWorkers[1] : 18577	PROD	Yes
3307	02/05/2017	11:52:03	individuals[710]	SH24ehk	technicalSupportWorkers[1] : 18577	USER	Yes
3308	02/05/2017	12:17:10	individuals[1199]	SH24ehk	technicalSupportWorkers[1] : 18577	PROD	Yes
3309	02/05/2017	14:11:17	individuals[121]	SH24ehk	technicalSupportWorkers[1] : 18577	PROD	Yes
3310	02/05/2017	14:41:48	individuals[220]	SH20	technicalSupportWorkers[1] : 18577	USER	Yes
3311	02/05/2017	15:01:38	individuals[557]	SH20	technicalSupportWorkers[1] : 18577	PROD	Yes
3312	02/05/2017	15:55:35	individuals[726]	SH24ehk	technicalSupportWorkers[1] : 18577	USER	Yes
3313	02/05/2017	16:34:59	wholesalers[15]	SH24	technicalSupportWorkers[1] : 18577	USER	Yes

Table A:3 TS record - Scenario 1

A.2 Dataset Scenario 2

A.2.1 Call Centre Log

CALL RECORD NUMBER	CALL DATE	CALL TIME	END CALL TIME	CUSTOMER NUMBER	CALL HANDLER	ISSUE	RESOLUTION	CLOSED AT CALL
18626	02/05/2017	9:03:31	9:17:04	individuals[1572]	callCenterWorkers[0] : 18614	PROD	PTREE	Yes
18638	02/05/2017	9:19:33	9:28:16	individuals[577]	callCenterWorkers[1] : 18615	PAY	ACCORD	Yes
18628	02/05/2017	9:04:54	9:13:38	individuals[565]	callCenterWorkers[1] : 18615	ORD	SALES	Yes
18636	02/05/2017	9:19:32	9:30:33	individuals[935]	callCenterWorkers[5] : 18619	PAY	ACCORD	Yes
18642	02/05/2017	9:27:14	9:34:41	individuals[1326]	callCenterWorkers[3] : 18617	PAY	ACCORD	Yes
18640	02/05/2017	9:21:39	9:35:12	individuals[1768]	callCenterWorkers[0] : 18614	ORD	ORDER	Yes
18634	02/05/2017	9:14:19	9:26:46	individuals[1617]	callCenterWorkers[4] : 18618	ORD	SALES	Yes
18652	02/05/2017	9:39:04	9:46:31	individuals[31]	callCenterWorkers[3] : 18617	DOA	BSPT	Yes
18654	02/05/2017	9:40:23	9:53:56	individuals[300]	callCenterWorkers[0] : 18614	ORD	ORDER	Yes
18656	02/05/2017	9:44:42	9:55:19	individuals[1673]	callCenterWorkers[2] : 18616	MIS	PSPT	Yes
18644	02/05/2017	9:29:10	9:39:48	individuals[92]	callCenterWorkers[2] : 18616	SET	TC	Yes
18648	02/05/2017	9:33:08	9:41:52	individuals[789]	callCenterWorkers[1] : 18615	ORD	SALES	Yes
18660	02/05/2017	9:53:15	10:05:42	wholesalers[3]	callCenterWorkers[4] : 18618	PAY	FIN	Yes
18658	02/05/2017	9:44:44	9:53:28	individuals[158]	callCenterWorkers[1] : 18615	DEAD	TC	Yes
18662	02/05/2017	9:55:03	10:02:30	individuals[183]	callCenterWorkers[3] : 18617	ORD	SALES	Yes
18674	02/05/2017	10:11:35	10:19:02	individuals[528]	callCenterWorkers[3] : 18617	ACC	ACCORD	Yes
18664	02/05/2017	9:56:21	10:07:23	networkDistributors[17]	callCenterWorkers[5] : 18619	ORD	SALES	Yes
18676	02/05/2017	10:16:39	10:29:06	individuals[1263]	callCenterWorkers[4] : 18618	SET	SSPT	Yes
18668	02/05/2017	10:01:43	10:15:16	individuals[800]	callCenterWorkers[0] : 18614	ORD	SALES	Yes
18672	02/05/2017	10:11:18	10:21:56	networkDistributors[1]	callCenterWorkers[2] : 18616	DEAD	TC	Yes
18682	02/05/2017	10:25:20	10:34:03	individuals[1899]	callCenterWorkers[1] : 18615	ORD	SALES	Yes
18684	02/05/2017	10:43:16	10:54:18	individuals[517]	callCenterWorkers[5] : 18619	DEL	DELI	Yes
18686	02/05/2017	10:50:46	11:04:19	individuals[1498]	callCenterWorkers[0] : 18614	PAY	FIN	Yes
18692	02/05/2017	10:54:28	11:05:05	individuals[1028]	callCenterWorkers[2] : 18616	ORD	SALES	Yes
18690	02/05/2017	10:52:41	11:00:08	networkDistributors[31]	callCenterWorkers[3] : 18617	DEAD	TC	Yes
18700	02/05/2017	11:20:17	11:27:44	individuals[175]	callCenterWorkers[3] : 18617	PAY	ACCORD	Yes
18696	02/05/2017	11:05:12	11:13:55	individuals[1775]	callCenterWorkers[1] : 18615	SET	TC	Yes
18694	02/05/2017	11:04:12	11:16:39	individuals[1651]	callCenterWorkers[4] : 18618	ORD	SALES	Yes
18706	02/05/2017	11:46:53	11:57:31	individuals[1090]	callCenterWorkers[2] : 18616	ORD	SALES	Yes
18722	02/05/2017	12:09:25	12:16:52	wholesalers[18]	callCenterWorkers[3] : 18617	ORD	ORDER	Yes
18712	02/05/2017	11:53:37	12:01:04	individuals[187]	callCenterWorkers[3] : 18617	SET	TC	Yes
18724	02/05/2017	12:13:04	12:25:30	individuals[461]	callCenterWorkers[4] : 18618	UNEX	FOLL	Yes
18714	02/05/2017	12:01:09	12:12:10	wholesalers[8]	callCenterWorkers[5] : 18619	ORD	SALES	Yes
18720	02/05/2017	12:07:18	12:20:51	individuals[1796]	callCenterWorkers[0] : 18614	DEAD	TC	Yes
18730	02/05/2017	12:18:12	12:29:13	individuals[850]	callCenterWorkers[5] : 18619	ORD	SALES	Yes
18738	02/05/2017	12:31:40	12:45:13	wholesalers[7]	callCenterWorkers[0] : 18614	ORD	ORDER	Yes
18742	02/05/2017	12:41:10	12:52:11	individuals[75]	callCenterWorkers[5] : 18619	PAY	ACCORD	Yes
18748	02/05/2017	12:52:45	13:03:23		callCenterWorkers[2] : 18616	UNEX	FOLL	Yes
18740	02/05/2017	12:37:50	12:50:16	individuals[1814]	callCenterWorkers[4] : 18618	ORD	SALES	Yes

18752	02/05/2017	12:57:12	13:09:38	wholesalers[11]	callCenterWorkers[4] : 18618	PAY	FIN	Yes
18756	02/05/2017	13:09:49	13:20:50	individuals[1197]	callCenterWorkers[5] : 18619	ORD	ORDER	Yes
18754	02/05/2017	12:58:28	13:05:55	individuals[873]	callCenterWorkers[3] : 18617	ORD	SALES	Yes
18750	02/05/2017	12:52:59	13:06:32	individuals[416]	callCenterWorkers[0] : 18614	PROD	TC	Yes
18764	02/05/2017	13:20:23	13:33:56	individuals[1963]	callCenterWorkers[0] : 18614	DEL	DELI	Yes
18762	02/05/2017	13:17:21	13:24:48	networkDistributors[17]	callCenterWorkers[3] : 18617	ORD	SALES	Yes
18758	02/05/2017	13:12:17	13:21:00	individuals[1766]	callCenterWorkers[1] : 18615	DEAD	TC	Yes
18766	02/05/2017	13:23:39	13:36:06	individuals[1239]	callCenterWorkers[4] : 18618	ORD	SALES	Yes
18782	02/05/2017	13:49:23	14:00:25	individuals[1714]	callCenterWorkers[5] : 18619	PAY	ACCORD	Yes
18768	02/05/2017	13:27:24	13:38:25	individuals[103]	callCenterWorkers[5] : 18619	DEAD	TC	Yes
18772	02/05/2017	13:41:27	13:48:54	networkDistributors[20]	callCenterWorkers[3] : 18617	ORD	SALES	Yes
18776	02/05/2017	13:42:48	13:56:21	individuals[1690]	callCenterWorkers[0] : 18614	ORD	SALES	Yes
18790	02/05/2017	14:21:29	14:26:29					
18794	02/05/2017	14:36:42	14:41:42					
18796	02/05/2017	14:36:47	14:41:47					
18800	02/05/2017	14:45:18	14:50:18					
18808	02/05/2017	14:56:42	15:01:42					
18816	02/05/2017	15:14:07	15:19:07					
18818	02/05/2017	15:15:25	15:20:25					
18822	02/05/2017	15:17:22	15:22:22					
18824	02/05/2017	15:18:22	15:23:22					
18826	02/05/2017	15:20:16	15:25:16					
18842	02/05/2017	15:50:28	15:55:28					
18844	02/05/2017	15:52:18	15:57:18					
18846	02/05/2017	16:01:21	16:14:54	individuals[46]	callCenterWorkers[0] : 18614	UNEX	FOLL	Yes
18848	02/05/2017	16:13:03	16:21:46	individuals[1927]	callCenterWorkers[1] : 18615	ORD	ORDER	Yes
18852	02/05/2017	16:20:02	16:32:29	individuals[327]	callCenterWorkers[4] : 18618	PAY	FIN	Yes
18856	02/05/2017	16:28:16	16:35:43	individuals[547]	callCenterWorkers[3] : 18617	UNEX	FOLL	Yes
18854	02/05/2017	16:21:26	16:32:04	wholesalers[6]	callCenterWorkers[2] : 18616	ORD	SALES	Yes
18858	02/05/2017	16:38:42	16:49:43		callCenterWorkers[5] : 18619	PROD	PTREE	Yes
18860	02/05/2017	16:40:35	16:54:08	individuals[968]	callCenterWorkers[0] : 18614	ORD	SALES	Yes
18862	02/05/2017	16:47:10	16:55:53	wholesalers[14]	callCenterWorkers[1] : 18615	DEAD	TC	Yes
18868	02/05/2017	17:03:37	17:11:04	individuals[1040]	callCenterWorkers[3] : 18617	ORD	SALES	Yes
18880	02/05/2017	17:28:20	17:39:21	wholesalers[12]	callCenterWorkers[5] : 18619	UNEX	FOLL	Yes
18874	02/05/2017	17:13:13	17:21:56	individuals[1035]	callCenterWorkers[1] : 18615	ORD	SALES	Yes
18876	02/05/2017	17:19:09	17:29:47	individuals[557]	callCenterWorkers[2] : 18616	SET	TC	Yes
18886	02/05/2017	17:31:25	17:40:09	individuals[772]	callCenterWorkers[1] : 18615	ORD	SALES	Yes
18894	02/05/2017	17:48:09	17:56:53	individuals[1086]	callCenterWorkers[1] : 18615	DOA	BSPT	Yes
18904	02/05/2017	17:57:36	18:08:37	individuals[545]	callCenterWorkers[5] : 18619	UNEX	FOLL	Yes
18892	02/05/2017	17:45:41	17:56:42	individuals[72]	callCenterWorkers[5] : 18619	ORD	SALES	Yes
18908	02/05/2017	18:06:40	18:19:07	networkDistributors[8]	callCenterWorkers[4] : 18618	MIS	PSPT	Yes
18900	02/05/2017	17:54:53	18:08:26	individuals[1121]	callCenterWorkers[0] : 18614	ORD	SALES	Yes
18918	02/05/2017	18:31:11	18:39:54	wholesalers[14]	callCenterWorkers[1] : 18615	UNEX	FOLL	Yes
18916	02/05/2017	18:29:00	18:40:01	individuals[1616]	callCenterWorkers[5] : 18619	ORD	SALES	Yes

18927	02/05/2017	18:47:31	18:56:15	individuals[1292]	callCenterWorkers[1] : 18615	SET	SSPT	Yes
18929	02/05/2017	18:48:43	18:59:44	individuals[1576]	callCenterWorkers[5] : 18619	PAY	ACCORD	Yes
18935	02/05/2017	18:56:41	19:07:19	wholesalers[3]	callCenterWorkers[2] : 18616	PAY	ACCORD	Yes
18925	02/05/2017	18:42:56	18:50:23	individuals[159]	callCenterWorkers[3] : 18617	ORD	SALES	Yes
18922	02/05/2017	18:41:52	18:52:30	individuals[495]	callCenterWorkers[2] : 18616	DEAD	TC	Yes

Table A:4 Call Centre Log - Scenario 2

A.2.2 Sales record

SALES ORDER NUMBER	CUSTOMER NUMBER	DATE	ITEMS	QUANTITY	PRICE	WARRANTY TERMS	DELIVERY	SALES STAFF
5063	individuals[565]	02/05/2017	SH24	1	60	NS	05/05/2017	salesWorkers[2] : 18624
5064	individuals[1617]	02/05/2017	SH20	1	40	NS	05/05/2017	salesWorkers[2] : 18624
5065	individuals[789]	02/05/2017	SH24	1	60	NS	08/05/2017	salesWorkers[2] : 18624
5066	individuals[183]	02/05/2017	SH24	1	60	NS	08/05/2017	salesWorkers[2] : 18624
5067	networkDistributors[15]	02/05/2017	NN23	125	Confidential in Commerce	24H	05/05/2017	salesWorkers[1] : 18623
5068	networkDistributors[17]	02/05/2017	NN28	125	Confidential in Commerce	24H	04/05/2017	salesWorkers[0] : 18620
5069	individuals[800]	02/05/2017	SH24	1	60	NS	04/05/2017	salesWorkers[2] : 18624
5070	networkDistributors[20]	02/05/2017	NN28	125	Confidential in Commerce	24H	05/05/2017	salesWorkers[1] : 18623
5071	networkDistributors[11]	02/05/2017	NN17	125	Confidential in Commerce	24H	08/05/2017	salesWorkers[0] : 18620
5072	individuals[1899]	02/05/2017	SH24ehk	1	80	NS	05/05/2017	salesWorkers[2] : 18624
5073	networkDistributors[30]	02/05/2017	NN41	125	Confidential in Commerce	24H	08/05/2017	salesWorkers[1] : 18623
5074	individuals[1028]	02/05/2017	SH24ehk	1	80	NS	04/05/2017	salesWorkers[2] : 18624
5075	individuals[1651]	02/05/2017	SH20	1	40	NS	08/05/2017	salesWorkers[2] : 18624
5076	networkDistributors[13]	02/05/2017	NN28	125	Confidential in Commerce	24H	05/05/2017	salesWorkers[1] : 18623
5077	individuals[1090]	02/05/2017	SH24	1	60	NS	04/05/2017	salesWorkers[2] : 18624
5078	wholesalers[8]	02/05/2017	SH24	3500	Confidential in Commerce	LM	05/05/2017	salesWorkers[2] : 18624
5079	networkDistributors[9]	02/05/2017	NN23	125	Confidential in Commerce	24H	05/05/2017	salesWorkers[0] : 18620
5080	networkDistributors[11]	02/05/2017	NN23	125	Confidential in Commerce	24H	05/05/2017	salesWorkers[1] : 18623
5081	individuals[850]	02/05/2017	SH20	1	40	NS	05/05/2017	salesWorkers[2] : 18624
5082	individuals[1814]	02/05/2017	SH24ehk	1	80	NS	08/05/2017	salesWorkers[2] : 18624
5083	individuals[873]	02/05/2017	SH20	1	40	NS	05/05/2017	salesWorkers[2] : 18624
5084	networkDistributors[17]	02/05/2017	NN23	125	Confidential in Commerce	24H	05/05/2017	salesWorkers[1] : 18623
5085	individuals[1239]	02/05/2017	SH24ehk	1	80	NS	08/05/2017	salesWorkers[2] : 18624
5086	networkDistributors[20]	02/05/2017	NN41	125	Confidential in Commerce	24H	05/05/2017	salesWorkers[1] : 18623
5087	individuals[1690]	02/05/2017	SH24ehk	1	80	NS	08/05/2017	salesWorkers[2] : 18624
5088	individuals[791]	02/05/2017	SH24ehk	1	80	NS	08/05/2017	
5089	individuals[1464]	02/05/2017	SH18	1	40	NS	05/05/2017	
5090	individuals[1431]	02/05/2017	SH18	1	40	NS	05/05/2017	
5091	individuals[1400]	02/05/2017	SH24	1	60	NS	04/05/2017	
5092	individuals[1835]	02/05/2017	SH24	1	60	NS	04/05/2017	
5093	individuals[1101]	02/05/2017	SH24	1	60	NS	05/05/2017	
5094	individuals[1290]	02/05/2017	SH24	1	60	NS	08/05/2017	
5095	individuals[299]	02/05/2017	SH24ehk	1	80	NS	08/05/2017	
5096	individuals[1032]	02/05/2017	SH18	1	40	NS	04/05/2017	

5097	individuals[1909]	02/05/2017	SH24ehk	1	80	NS	05/05/2017	
5098	individuals[1307]	02/05/2017	SH24	1	60	NS	05/05/2017	
5099	individuals[914]	02/05/2017	SH24ehk	1	80	NS	04/05/2017	
5100	individuals[1231]	02/05/2017	SH20	1	40	NS	05/05/2017	
5101	individuals[744]	02/05/2017	SH24ehk	1	80	NS	04/05/2017	
5102	individuals[229]	02/05/2017	SH24ehk	1	80	NS	08/05/2017	
5103	individuals[1892]	02/05/2017	SH24	1	60	NS	05/05/2017	
5104	individuals[1520]	02/05/2017	SH24ehk	1	80	NS	05/05/2017	
5105	wholesalers[6]	02/05/2017	SH18	3500	Confidential in Commerce	LM	04/05/2017	salesWorkers[2] : 18624
5106	individuals[968]	02/05/2017	SH24	1	60	NS	05/05/2017	salesWorkers[2] : 18624
5107	individuals[1040]	02/05/2017	SH18	1	40	NS	05/05/2017	salesWorkers[2] : 18624
5108	individuals[1035]	02/05/2017	SH24	1	60	NS	05/05/2017	salesWorkers[2] : 18624
5109	individuals[772]	02/05/2017	SH18	1	40	NS	05/05/2017	salesWorkers[2] : 18624
5110	individuals[72]	02/05/2017	SH24	1	60	NS	05/05/2017	salesWorkers[2] : 18624
5111	individuals[1121]	02/05/2017	SH18	1	40	NS	05/05/2017	salesWorkers[2] : 18624
5112	individuals[1616]	02/05/2017	SH24ehk	1	80	NS	04/05/2017	salesWorkers[2] : 18624
5113	individuals[159]	02/05/2017	SH24	1	60	NS	04/05/2017	salesWorkers[2] : 18624

Table A:5 Sales record - Scenario 2

A.2.3 TS record

SUPPORT CALL NUMBER	CALL DATE	CALL TIME	CUSTOMER NUMBER	ITEM	TS ENGINEER	ISSUE	RESOLVED
3300	02/05/2017	9:39:48	individuals[92]	SH24	technicalSupportWorkers[1] : 18622	USER	Yes
3301	02/05/2017	9:53:28	individuals[158]	SH20	technicalSupportWorkers[1] : 18622	PROD	Yes
3302	02/05/2017	10:21:56	networkDistributors[1]	NN12	technicalSupportWorkers[0] : 18621	PROD	Yes
3303	02/05/2017	11:00:08	networkDistributors[31]	NN11	technicalSupportWorkers[0] : 18621	PROD	Yes
3304	02/05/2017	11:13:55	individuals[1775]	SH18	technicalSupportWorkers[1] : 18622	USER	Yes
3305	02/05/2017	12:01:04	individuals[187]	SH24ehk	technicalSupportWorkers[1] : 18622	USER	Yes
3306	02/05/2017	12:20:51	individuals[1796]	SH24ehk	technicalSupportWorkers[1] : 18622	PROD	Yes
3307	02/05/2017	13:06:32	individuals[416]	SH24ehk	technicalSupportWorkers[1] : 18622	USER	Yes
3308	02/05/2017	13:21:00	individuals[1766]	SH24ehk	technicalSupportWorkers[1] : 18622	PROD	Yes
3309	02/05/2017	13:38:25	individuals[103]	SH20	technicalSupportWorkers[1] : 18622	PROD	Yes
3310	02/05/2017	16:16:46	networkDistributors[21]	NN23	technicalSupportWorkers[0] : 18621	PROD	Yes
3311	02/05/2017	16:55:53	wholesalers[14]	SH24ehk	technicalSupportWorkers[1] : 18622	PROD	Yes
3312	02/05/2017	17:29:47	individuals[557]	SH24	technicalSupportWorkers[1] : 18622	USER	Yes
3313	02/05/2017	18:52:30	individuals[495]	SH18	technicalSupportWorkers[1] : 18622	PROD	Yes

Table A:6 TS record - Scenario 2

A.3 Dataset Scenario 3

A.3.1 Call Centre Log

CALL RECORD NUMBER	CALL DATE	CALL TIME	END CALL TIME	CUSTOMER NUMBER	CALL HANDLER	ISSUE	RESOLUTION	CLOSED AT CALL
18607	02/05/2017	9:03:31	9:13:31	individuals[555]	callCenterWorkers[0] : 18595	PAY	FIN	Yes
18609	02/05/2017	9:04:10	9:14:10	networkDistributors[6]	callCenterWorkers[1] : 18596	ORD	ORDER	Yes
18613	02/05/2017	9:13:11	9:23:11	individuals[997]	callCenterWorkers[3] : 18598	ORD	ORDER	Yes
18617	02/05/2017	9:19:32	9:29:32	individuals[1184]	callCenterWorkers[5] : 18600	ORD	ORDER	Yes
18619	02/05/2017	9:19:33	9:29:33	individuals[1540]	callCenterWorkers[0] : 18595	DEL	DELI	Yes
18621	02/05/2017	9:19:44	9:29:44	networkDistributors[26]	callCenterWorkers[1] : 18596	DOA	BSPT	Yes
18623	02/05/2017	9:21:39	9:22:30	individuals[360]	callCenterWorkers[2] : 18597	UNEX	FOLL	Yes
18611	02/05/2017	9:12:30	9:22:30	individuals[478]	callCenterWorkers[2] : 18597	ORD	SALES	Yes
18627	02/05/2017	9:31:36	9:41:36	networkDistributors[28]	callCenterWorkers[4] : 18599	UNEX	FOLL	Yes
18637	02/05/2017	9:39:04	9:49:04	individuals[1276]	callCenterWorkers[3] : 18598	CAN	SUB	Yes
18639	02/05/2017	9:40:23	9:41:36		callCenterWorkers[4] : 18599	PROD	PTREE	Yes
18629	02/05/2017	9:31:50	9:41:50	wholesalers[13]	callCenterWorkers[5] : 18600	ORD	SALES	Yes
18625	02/05/2017	9:27:14	9:37:14	individuals[799]	callCenterWorkers[3] : 18598	DEAD	TC	Yes
18649	02/05/2017	10:01:43	10:11:43	individuals[90]	callCenterWorkers[3] : 18598	ACC	ACCORD	Yes
18641	02/05/2017	9:44:42	9:54:42	individuals[452]	callCenterWorkers[5] : 18600	ORD	SALES	Yes
18651	02/05/2017	10:11:32	10:21:32	wholesalers[3]	callCenterWorkers[4] : 18599	PAY	FIN	Yes
18653	02/05/2017	10:11:35	10:21:35	individuals[1586]	callCenterWorkers[5] : 18600	ACC	FIN	Yes
18647	02/05/2017	9:57:43	10:07:43	individuals[418]	callCenterWorkers[2] : 18597	SET	TC	Yes
18655	02/05/2017	10:16:39	10:26:39	individuals[858]	callCenterWorkers[0] : 18595	ORD	SALES	Yes
18665	02/05/2017	10:41:06	10:51:06	networkDistributors[2]	callCenterWorkers[3] : 18598	MIS	PSPT	Yes
18667	02/05/2017	10:43:16	10:53:16	individuals[1599]	callCenterWorkers[4] : 18599	ORD	ORDER	Yes
18663	02/05/2017	10:32:43	10:42:43	wholesalers[8]	callCenterWorkers[2] : 18597	ORD	SALES	Yes
18671	02/05/2017	10:50:46	11:00:46	individuals[625]	callCenterWorkers[5] : 18600	ORD	SALES	Yes
18677	02/05/2017	11:00:55	11:10:55	networkDistributors[15]	callCenterWorkers[2] : 18597	ORD	SALES	Yes
18673	02/05/2017	10:52:41	11:02:41	networkDistributors[14]	callCenterWorkers[0] : 18595	DEAD	TC	Yes
18681	02/05/2017	11:20:17	11:30:17	individuals[1936]	callCenterWorkers[4] : 18599	ACC	FIN	Yes
18679	02/05/2017	11:05:12	11:15:12	individuals[352]	callCenterWorkers[3] : 18598	ORD	SALES	Yes
18687	02/05/2017	11:46:53	11:56:53	individuals[1030]	callCenterWorkers[0] : 18595	DEL	DELI	Yes
18689	02/05/2017	11:49:55	11:59:55	individuals[902]	callCenterWorkers[1] : 18596	ORD	ORDER	Yes
18693	02/05/2017	11:53:37	12:03:37	individuals[1923]	callCenterWorkers[3] : 18598	ORD	ORDER	Yes
18697	02/05/2017	11:59:59	12:09:59	networkDistributors[7]	callCenterWorkers[5] : 18600	ACC	FIN	Yes
18685	02/05/2017	11:45:46	11:55:46	individuals[1095]	callCenterWorkers[5] : 18600	ORD	SALES	Yes
18703	02/05/2017	12:07:03	12:17:03	individuals[502]	callCenterWorkers[2] : 18597	PAY	FIN	Yes
18695	02/05/2017	11:54:27	12:04:27	networkDistributors[30]	callCenterWorkers[4] : 18599	ORD	SALES	Yes
18707	02/05/2017	12:13:04	12:23:04	individuals[1657]	callCenterWorkers[4] : 18599	ORD	ORDER	Yes
18699	02/05/2017	12:01:39	12:11:39	wholesalers[12]	callCenterWorkers[0] : 18595	ORD	SALES	Yes
18709	02/05/2017	12:18:12	12:28:12	individuals[1269]	callCenterWorkers[5] : 18600	DEL	DELI	Yes
18713	02/05/2017	12:20:52	12:30:52	individuals[171]	callCenterWorkers[1] : 18596	ORD	SALES	Yes
18711	02/05/2017	12:20:16	12:30:16	individuals[260]	callCenterWorkers[0] : 18595	SET	TC	Yes
18717	02/05/2017	12:27:33	12:37:33	networkDistributors[8]	callCenterWorkers[3] : 18598	ORD	SALES	Yes

18726	02/05/2017	12:52:45	13:02:45		callCenterWorkers[1] : 18596	UNEX	FOLL	Yes
18719	02/05/2017	12:37:50	12:47:50	individuals[311]	callCenterWorkers[4] : 18599	ORD	SALES	Yes
18728	02/05/2017	12:52:59	13:02:59	individuals[1701]	callCenterWorkers[2] : 18597	ORD	SALES	Yes
18732	02/05/2017	13:09:49	13:19:49	individuals[922]	callCenterWorkers[4] : 18599	ORD	ORDER	Yes
18736	02/05/2017	13:14:13	13:24:13	individuals[352]	callCenterWorkers[0] : 18595	ORD	ORDER	Yes
18738	02/05/2017	13:16:53	13:26:53	individuals[689]	callCenterWorkers[1] : 18596	PAY	FIN	Yes
18734	02/05/2017	13:12:17	13:22:17	individuals[362]	callCenterWorkers[5] : 18600	ORD	SALES	Yes
18740	02/05/2017	13:20:23	13:30:23	individuals[159]	callCenterWorkers[2] : 18597	DEAD	TC	Yes
18744	02/05/2017	13:29:08	13:39:08	individuals[861]	callCenterWorkers[4] : 18599	ORD	SALES	Yes
18752	02/05/2017	13:47:57	13:57:57		callCenterWorkers[2] : 18597	UNEX	FOLL	Yes
18754	02/05/2017	13:49:05	13:59:05	individuals[1125]	callCenterWorkers[3] : 18598	PAY	FIN	Yes
18756	02/05/2017	13:49:23	13:59:23	individuals[412]	callCenterWorkers[4] : 18599	PAY	ACCORD	Yes
18760	02/05/2017	13:55:37	14:05:37	individuals[1684]	callCenterWorkers[0] : 18595	PAY	ACCORD	Yes
18746	02/05/2017	13:42:42	13:52:42	individuals[1249]	callCenterWorkers[5] : 18600	ORD	SALES	Yes
18764	02/05/2017	14:01:25	14:11:25	individuals[1400]	callCenterWorkers[2] : 18597	ACC	ACCORD	Yes
18770	02/05/2017	14:10:34	14:20:34	individuals[1917]	callCenterWorkers[5] : 18600	PAY	ACCORD	Yes
18772	02/05/2017	14:13:28	14:23:28	individuals[1518]	callCenterWorkers[0] : 18595	PAY	ACCORD	Yes
18762	02/05/2017	13:58:43	14:08:43	individuals[125]	callCenterWorkers[1] : 18596	ORD	SALES	Yes
18758	02/05/2017	13:54:37	14:04:37	wholesalers[3]	callCenterWorkers[5] : 18600	SET	TC	Yes
18776	02/05/2017	14:27:37	14:37:37	individuals[1550]	callCenterWorkers[2] : 18597	ORD	ORDER	Yes
18768	02/05/2017	14:10:20	14:20:20	individuals[1762]	callCenterWorkers[4] : 18599	ORD	SALES	Yes
18774	02/05/2017	14:16:10	14:26:10	individuals[258]	callCenterWorkers[1] : 18596	DEAD	TC	Yes
18778	02/05/2017	14:30:42	14:40:42	individuals[804]	callCenterWorkers[3] : 18598	ORD	SALES	Yes
18788	02/05/2017	14:54:53	15:04:53	wholesalers[19]	callCenterWorkers[1] : 18596	DEL	DELI	Yes
18784	02/05/2017	14:46:34	14:56:34	individuals[1787]	callCenterWorkers[5] : 18600	ORD	SALES	Yes
18792	02/05/2017	15:08:52	15:18:52	individuals[958]	callCenterWorkers[3] : 18598	ORD	ORDER	Yes
18786	02/05/2017	14:49:30	14:59:30	individuals[523]	callCenterWorkers[0] : 18595	SET	TC	Yes
18794	02/05/2017	15:10:02	15:20:02	individuals[1380]	callCenterWorkers[4] : 18599	DOA	BSPT	Yes
18802	02/05/2017	15:16:52	15:26:52		callCenterWorkers[1] : 18596	UNEX	FOLL	Yes
18806	02/05/2017	15:23:00	15:33:00	individuals[713]	callCenterWorkers[3] : 18598	ORD	ORDER	Yes
18796	02/05/2017	15:11:10	15:21:10	individuals[31]	callCenterWorkers[5] : 18600	ORD	SALES	Yes
18790	02/05/2017	15:04:35	15:14:35	individuals[683]	callCenterWorkers[2] : 18597	PROD	TC	Yes
18810	02/05/2017	15:31:17	15:41:17	individuals[1117]	callCenterWorkers[4] : 18599	PAY	ACCORD	Yes
18804	02/05/2017	15:22:08	15:32:08	networkDistributors[24]	callCenterWorkers[2] : 18597	ORD	SALES	Yes
18812	02/05/2017	15:34:30	15:44:30	individuals[681]	callCenterWorkers[5] : 18600	ORD	SALES	Yes
18814	02/05/2017	15:37:23	15:47:23	individuals[239]	callCenterWorkers[0] : 18595	PROD	TC	Yes
18828	02/05/2017	16:03:29	16:13:29	individuals[685]	callCenterWorkers[1] : 18596	UNEX	FOLL	Yes
18832	02/05/2017	16:04:04	16:14:04	individuals[1621]	callCenterWorkers[3] : 18598	ACC	FIN	Yes
18818	02/05/2017	15:45:23	15:55:23	individuals[1641]	callCenterWorkers[2] : 18597	ORD	SALES	Yes
18834	02/05/2017	16:05:11	16:15:11	individuals[111]	callCenterWorkers[4] : 18599	DEL	DELI	Yes
18838	02/05/2017	16:10:57	16:20:57	individuals[980]	callCenterWorkers[0] : 18595	DEL	DELI	Yes
18842	02/05/2017	16:16:58	16:26:58	individuals[133]	callCenterWorkers[2] : 18597	ORD	ORDER	Yes
18846	02/05/2017	16:17:49	16:27:49	individuals[846]	callCenterWorkers[4] : 18599	PAY	ACCORD	Yes
18830	02/05/2017	16:03:49	16:13:49	individuals[64]	callCenterWorkers[2] : 18597	ORD	SALES	Yes

18848	02/05/2017	16:21:43	16:31:43	individuals[1374]	callCenterWorkers[5] : 18600	UNEX	FOLL	Yes
18840	02/05/2017	16:15:49	16:25:49	individuals[803]	callCenterWorkers[1] : 18596	ORD	SALES	Yes
18852	02/05/2017	16:29:00	16:39:00	individuals[549]	callCenterWorkers[1] : 18596	PROD	TC	Yes
18854	02/05/2017	16:30:39	16:40:39	individuals[1890]	callCenterWorkers[2] : 18597	ORD	SALES	Yes
18864	02/05/2017	16:51:02	17:01:02	individuals[635]	callCenterWorkers[1] : 18596	CAN	SUB	Yes
18868	02/05/2017	16:55:34	17:05:34	individuals[238]	callCenterWorkers[3] : 18598	ACC	ACCORD	Yes
18872	02/05/2017	16:57:11	17:07:11	individuals[1402]	callCenterWorkers[5] : 18600	ORD	ORDER	Yes
18858	02/05/2017	16:46:33	16:56:33	individuals[1785]	callCenterWorkers[4] : 18599	ORD	SALES	Yes

Table A:7 Call Centre Log - Scenario 3

A.3.2 Sales record

SALES ORDER NUMBER	CUSTOMER NUMBER	DATE	ITEMS	QUANTITY	PRICE	WARRANTY TERMS	DELIVERY	SALES STAFF
5063	individuals[478]	02/05/2017	NN23	1	1200	NS	08/05/2017	salesWorkers[2] : 18605
5064	wholesalers[13]	02/05/2017	NN23	1998	Confidential in Commerce	LM	05/05/2017	salesWorkers[2] : 18605
5065	individuals[452]	02/05/2017	SH18	1	40	NS	08/05/2017	salesWorkers[2] : 18605
5066	networkDistributors[0]	02/05/2017	NN28	1463	Confidential in Commerce	24H	05/05/2017	salesWorkers[1] : 18604
5067	networkDistributors[20]	02/05/2017	NN28	855	Confidential in Commerce	24H	08/05/2017	salesWorkers[0] : 18601
5068	individuals[858]	02/05/2017	SH24	1	60	NS	05/05/2017	salesWorkers[2] : 18605
5069	wholesalers[8]	02/05/2017	NN41	2561	Confidential in Commerce	LM	04/05/2017	salesWorkers[2] : 18605
5070	individuals[625]	02/05/2017	SH20	1	40	NS	08/05/2017	salesWorkers[2] : 18605
5071	networkDistributors[15]	02/05/2017	SH20	1459	Confidential in Commerce	24H	08/05/2017	salesWorkers[1] : 18604
5072	individuals[352]	02/05/2017	SH18	1	40	NS	08/05/2017	salesWorkers[2] : 18605
5073	networkDistributors[18]	02/05/2017	NN23	912	Confidential in Commerce	24H	05/05/2017	salesWorkers[0] : 18601
5074	individuals[1095]	02/05/2017	SH18	1	40	NS	08/05/2017	salesWorkers[2] : 18605
5075	networkDistributors[30]	02/05/2017	SH20	1493	Confidential in Commerce	24H	05/05/2017	salesWorkers[1] : 18604
5076	wholesalers[12]	02/05/2017	SH24	2237	Confidential in Commerce	LM	05/05/2017	salesWorkers[2] : 18605
5077	individuals[171]	02/05/2017	NN23	1	1200	NS	08/05/2017	salesWorkers[2] : 18605
5078	networkDistributors[8]	02/05/2017	NN23	674	Confidential in Commerce	24H	08/05/2017	salesWorkers[1] : 18604
5079	individuals[311]	02/05/2017	SH20	1	40	NS	04/05/2017	salesWorkers[2] : 18605
5080	individuals[1701]	02/05/2017	NN23	1	1200	NS	05/05/2017	salesWorkers[2] : 18605
5081	individuals[362]	02/05/2017	NN23	1	1200	NS	04/05/2017	salesWorkers[2] : 18605
5082	individuals[861]	02/05/2017	SH18	1	40	NS	05/05/2017	salesWorkers[2] : 18605
5083	individuals[1249]	02/05/2017	NN28	1	850	NS	05/05/2017	salesWorkers[2] : 18605
5084	individuals[125]	02/05/2017	NN23	1	1200	NS	08/05/2017	salesWorkers[2] : 18605
5085	individuals[1762]	02/05/2017	NN23	1	1200	NS	08/05/2017	salesWorkers[2] : 18605
5086	networkDistributors[0]	02/05/2017	NN28	1463	Confidential in Commerce	24H	05/05/2017	salesWorkers[1] : 18604
5087	individuals[804]	02/05/2017	NN28	1	850	NS	05/05/2017	salesWorkers[2] : 18605
5088	individuals[1787]	02/05/2017	NN41	1	1075	NS	08/05/2017	salesWorkers[2] : 18605
5089	networkDistributors[33]	02/05/2017	SH18	501	Confidential in	24H	05/05/2017	salesWorkers[1] : 18604

					Commerce			
5090	individuals[31]	02/05/2017	SH20	1	40	NS	05/05/2017	salesWorkers[2] : 18605
5091	networkDistributors[1]	02/05/2017	NN28	759	Confidential in Commerce	24H	05/05/2017	salesWorkers[1] : 18604
5092	networkDistributors[24]	02/05/2017	NN28	585	Confidential in Commerce	24H	05/05/2017	salesWorkers[0] : 18601
5093	individuals[681]	02/05/2017	NN17	1	240	NS	05/05/2017	salesWorkers[2] : 18605
5094	individuals[1641]	02/05/2017	SH18	1	40	NS	05/05/2017	salesWorkers[2] : 18605
5095	individuals[64]	02/05/2017	SH18	1	40	NS	05/05/2017	salesWorkers[2] : 18605
5096	individuals[803]	02/05/2017	SH18	1	40	NS	05/05/2017	salesWorkers[2] : 18605
5097	individuals[1890]	02/05/2017	SH24ehk	1	80	NS	05/05/2017	salesWorkers[2] : 18605
5098	individuals[1785]	02/05/2017	NN17	1	240	NS	08/05/2017	salesWorkers[2] : 18605

Table A:8 Sales record - Scenario 3

A.3.3 TS record

SUPPORT CALL NUMBER	CALL DATE	CALL TIME	CUSTOMER NUMBER	ITEM	TS ENGINEER	ISSUE	RESOLVED
3300	02/05/2017	9:37:14	individuals[799]	NN28	technicalSupportWorkers[1] : 18603	PROD	Yes
3301	02/05/2017	10:07:43	individuals[418]	NN23	technicalSupportWorkers[1] : 18603	USER	Yes
3302	02/05/2017	10:46:46	networkDistributors[8]	SH24ehk	technicalSupportWorkers[0] : 18602	USER	Yes
3303	02/05/2017	11:02:41	networkDistributors[14]	NN12	technicalSupportWorkers[0] : 18602	PROD	Yes
3304	02/05/2017	12:30:16	individuals[260]	NN28	technicalSupportWorkers[1] : 18603	USER	Yes
3305	02/05/2017	13:30:23	individuals[159]	NN28	technicalSupportWorkers[1] : 18603	PROD	Yes
3306	02/05/2017	14:04:37	wholesalers[3]	SH24	technicalSupportWorkers[1] : 18603	USER	Yes
3307	02/05/2017	14:26:10	individuals[258]	NN17	technicalSupportWorkers[1] : 18603	PROD	Yes
3308	02/05/2017	14:59:30	individuals[523]	NN41	technicalSupportWorkers[1] : 18603	USER	Yes
3309	02/05/2017	15:14:35	individuals[683]	NN23	technicalSupportWorkers[1] : 18603	USER	Yes
3310	02/05/2017	15:47:23	individuals[239]	SH20	technicalSupportWorkers[1] : 18603	USER	Yes
3311	02/05/2017	16:39:00	individuals[549]	SH18	technicalSupportWorkers[1] : 18603	USER	Yes

Table A:9 TS record - Scenario 3

A.4 Dataset Scenario 4

A.4.1 Call Centre Log

CALL RECORD NUMBER	CALL DATE	CALL TIME	END CALL TIME	CUSTOMER NUMBER	CALL HANDLER	ISSUE	RESOLUTION	CLOSED AT CALL
18583	02/05/2017	9:05:46	9:15:46	individuals[1008]	callCenterWorkers[1] : 18570	ORD	SALES	Yes
18585	02/05/2017	9:21:22	9:31:22	individuals[815]	callCenterWorkers[2] : 18571	DOA	BSPT	Yes
18581	02/05/2017	9:04:50	9:14:50	individuals[346]	callCenterWorkers[0] : 18569	DEAD	TC	Yes
18591	02/05/2017	9:32:38	9:42:38	individuals[455]	callCenterWorkers[5] : 18574	PAY	FIN	Yes
18587	02/05/2017	9:22:05	9:32:05	individuals[1777]	callCenterWorkers[3] : 18572	ORD	SALES	Yes
18595	02/05/2017	9:44:15	9:54:15	individuals[500]	callCenterWorkers[1] : 18570	ORD	ORDER	Yes
18605	02/05/2017	9:51:24	10:01:24	individuals[1198]	callCenterWorkers[0] : 18569	DEL	DELI	Yes
18593	02/05/2017	9:36:55	9:46:55	networkDistributors[25]	callCenterWorkers[0] : 18569	ORD	SALES	Yes
18589	02/05/2017	9:32:37	9:42:37	networkDistributors[14]	callCenterWorkers[4] : 18573	PROD	TC	Yes
18607	02/05/2017	9:52:54	9:54:15	individuals[276]	callCenterWorkers[1] : 18570	ORD	ORDER	Yes
18597	02/05/2017	9:46:43	9:56:43		callCenterWorkers[2] : 18571	ORD	SALES	Yes
18613	02/05/2017	10:04:29	10:14:29	individuals[1589]	callCenterWorkers[4] : 18573	ACC	FIN	Yes
18599	02/05/2017	9:47:18	9:57:18		callCenterWorkers[3] : 18572	PROD	TC	Yes
18615	02/05/2017	10:08:22	10:18:22	individuals[833]	callCenterWorkers[5] : 18574	PAY	FIN	Yes
18621	02/05/2017	10:15:01	10:25:01	individuals[1768]	callCenterWorkers[2] : 18571	PAY	ACCORD	Yes
18611	02/05/2017	9:59:28	10:09:28	individuals[234]	callCenterWorkers[3] : 18572	ORD	SALES	Yes
18617	02/05/2017	10:08:29	10:18:29	individuals[1450]	callCenterWorkers[0] : 18569	SET	TC	Yes
18625	02/05/2017	10:29:12	10:39:12		callCenterWorkers[4] : 18573	MIS	PSPT	Yes
18629	02/05/2017	10:35:32	10:45:32	individuals[1481]	callCenterWorkers[0] : 18569	ACC	FIN	Yes
18623	02/05/2017	10:26:49	10:36:49	individuals[542]	callCenterWorkers[3] : 18572	ORD	SALES	Yes
18633	02/05/2017	10:47:33	10:57:33	individuals[1688]	callCenterWorkers[2] : 18571	DEL	DELI	Yes
18635	02/05/2017	10:48:06	10:58:06	individuals[219]	callCenterWorkers[3] : 18572	UNEX	FOLL	Yes
18641	02/05/2017	10:55:51	11:05:51	individuals[843]	callCenterWorkers[0] : 18569	PAY	FIN	Yes
18631	02/05/2017	10:40:57	10:50:57	individuals[480]	callCenterWorkers[1] : 18570	SET	TC	Yes
18637	02/05/2017	10:49:09	10:59:09	individuals[1841]	callCenterWorkers[4] : 18573	ORD		Yes
18649	02/05/2017	11:04:45	11:14:45	individuals[174]	callCenterWorkers[4] : 18573	DOA	BSPT	Yes
18643	02/05/2017	11:01:38	11:11:38	individuals[1456]	callCenterWorkers[1] : 18570	ORD	SALES	Yes
18657	02/05/2017	11:19:50	11:29:50	individuals[1172]	callCenterWorkers[2] : 18571	ORD	ORDER	Yes
18659	02/05/2017	11:20:45	11:30:45		callCenterWorkers[3] : 18572	UNEX	FOLL	Yes
18645	02/05/2017	11:03:53	11:13:53	individuals[265]	callCenterWorkers[2] : 18571	DEAD	TC	Yes
18663	02/05/2017	11:29:19	11:39:19	individuals[1908]	callCenterWorkers[5] : 18574	PAY	FIN	Yes
18665	02/05/2017	11:33:49	11:43:49		callCenterWorkers[0] : 18569	UNEX	FOLL	Yes
18655	02/05/2017	11:18:11	11:28:11	individuals[637]	callCenterWorkers[1] : 18570		SALES	Yes
18661	02/05/2017	11:21:59	11:31:59	wholesalers[2]	callCenterWorkers[4] : 18573	DEAD	TC	Yes
18675	02/05/2017	11:53:02	12:03:02	individuals[120]	callCenterWorkers[4] : 18573	ACC	FIN	Yes
18679	02/05/2017	11:54:47	12:04:47	individuals[1070]	callCenterWorkers[0] : 18569	DEL	DELI	Yes
18669	02/05/2017	11:39:57	11:49:57	individuals[1909]	callCenterWorkers[1] : 18570	ORD		Yes
18671	02/05/2017	11:42:03	11:52:03	individuals[710]	callCenterWorkers[2] : 18571	SET	TC	Yes
18677	02/05/2017	11:53:49	12:03:49	individuals[1494]	callCenterWorkers[5] : 18574	ORD	SALES	Yes
18684	02/05/2017	12:21:01	12:31:01	individuals[92]	callCenterWorkers[2] : 18571	ACC	ACCORD	Yes

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18686	02/05/2017	12:21:16	12:31:16	individuals[738]	callCenterWorkers[3] : 18572	DEL	DELI	Yes
18690	02/05/2017	12:22:12	12:32:12		callCenterWorkers[5] : 18574	PAY	ACCORD	Yes
18682	02/05/2017	12:07:10	12:17:10	individuals[1199]	callCenterWorkers[1] : 18570	DEAD	TC	Yes
18694	02/05/2017	12:34:22	12:44:22	networkDistributors[0]	callCenterWorkers[1] : 18570	DEL	DELI	Yes
18696	02/05/2017	12:34:26	12:44:26	networkDistributors[22]	callCenterWorkers[2] : 18571	PAY	FIN	Yes
18698	02/05/2017	12:34:28	12:44:28	wholesalers[7]	callCenterWorkers[3] : 18572	PAY	FIN	Yes
18688	02/05/2017	12:21:16	12:31:16	individuals[1691]	callCenterWorkers[4] : 18573	ORD	SALES	Yes
18700	02/05/2017	12:39:30	12:49:30	individuals[1694]	callCenterWorkers[4] : 18573	MIS	RETN	Yes
18704	02/05/2017	12:46:14	12:56:14	individuals[1418]	callCenterWorkers[0] : 18569	ORD	ORDER	Yes
18708	02/05/2017	12:54:37	13:04:37	individuals[1934]	callCenterWorkers[2] : 18571	PAY	FIN	Yes
18710	02/05/2017	13:00:20	13:10:20		callCenterWorkers[3] : 18572	UNEX	FOLL	Yes
18702	02/05/2017	12:45:42	12:55:42	individuals[1143]	callCenterWorkers[5] : 18574	ORD	SALES	Yes
18712	02/05/2017	13:03:24	13:13:24	individuals[1333]	callCenterWorkers[4] : 18573	PAY	FIN	Yes
18716	02/05/2017	13:09:42	13:19:42	networkDistributors[6]	callCenterWorkers[0] : 18569	PAY	ACCORD	Yes
18722	02/05/2017	13:18:19	13:28:19	individuals[1765]	callCenterWorkers[3] : 18572	PAY	FIN	Yes
18714	02/05/2017	13:06:15	13:16:15	individuals[374]	callCenterWorkers[5] : 18574	ORD		Yes
18724	02/05/2017	13:22:19	13:32:19	individuals[1187]	callCenterWorkers[4] : 18573	PAY	FIN	Yes
18718	02/05/2017	13:15:11	13:25:11	networkDistributors[13]	callCenterWorkers[1] : 18570	ORD	SALES	Yes
18729	02/05/2017	13:45:14	13:55:14	individuals[1223]	callCenterWorkers[0] : 18569	UNEX	FOLL	Yes
18731	02/05/2017	13:47:22	13:57:22	individuals[297]	callCenterWorkers[1] : 18570	ACC	ACCORD	Yes
18727	02/05/2017	13:44:25	13:54:25		callCenterWorkers[5] : 18574	ORD	SALES	Yes
18737	02/05/2017	13:55:02	14:05:02	individuals[1663]	callCenterWorkers[4] : 18573	ORD	SALES	Yes
18739	02/05/2017	14:01:17	14:11:17		callCenterWorkers[5] : 18574	DEAD	TC	Yes
18751	02/05/2017	14:24:32	14:34:32	individuals[1849]	callCenterWorkers[5] : 18574	ACC	FIN	Yes
18755	02/05/2017	14:29:05	14:39:05	individuals[1735]	callCenterWorkers[1] : 18570	UNEX	FOLL	Yes
18749	02/05/2017	14:20:41	14:30:41	individuals[866]	callCenterWorkers[4] : 18573	ORD	SALES	Yes
18761	02/05/2017	14:33:31	14:43:31	individuals[1091]	callCenterWorkers[4] : 18573	ORD	SALES	Yes
18759	02/05/2017	14:31:48	14:41:48	individuals[220]	callCenterWorkers[3] : 18572	PROD	TC	Yes
18765	02/05/2017	14:47:32	14:57:32	individuals[1639]	callCenterWorkers[0] : 18569	ORD	SALES	Yes
18769	02/05/2017	14:51:38	15:01:38	individuals[557]	callCenterWorkers[2] : 18571	DEAD	TC	Yes
18777	02/05/2017	15:01:09	15:11:09	individuals[76]	callCenterWorkers[0] : 18569	ORD	SALES	Yes
18789	02/05/2017	15:31:52	15:41:52	individuals[24]	callCenterWorkers[5] : 18574	MIS	PSPT	Yes
18781	02/05/2017	15:21:55	15:31:55	individuals[1543]	callCenterWorkers[2] : 18571	ORD	SALES	Yes
18799	02/05/2017	15:44:57	15:54:57	individuals[87]	callCenterWorkers[4] : 18573		FIN	Yes
18785	02/05/2017	15:30:26	15:40:26	networkDistributors[15]	callCenterWorkers[3] : 18572	ORD	SALES	Yes
18787	02/05/2017	15:30:29	15:40:29	networkDistributors[24]	callCenterWorkers[4] : 18573	ORD	SALES	Yes
18791	02/05/2017	15:34:39	15:44:39	individuals[243]	callCenterWorkers[0] : 18569		SALES	Yes
18807	02/05/2017	15:53:20	16:03:20	individuals[1460]	callCenterWorkers[2] : 18571	DEL	DELI	Yes
18811	02/05/2017	15:55:18	16:05:18	wholesalers[4]	callCenterWorkers[4] : 18573	ACC	FIN	Yes
18817	02/05/2017	16:00:28	16:10:28	individuals[1052]	callCenterWorkers[1] : 18570	UNEX	FOLL	Yes
18803	02/05/2017	15:45:35	15:55:35	individuals[726]	callCenterWorkers[0] : 18569	SET	TC	Yes
18821	02/05/2017	16:11:09	16:21:09	individuals[1500]	callCenterWorkers[3] : 18572	DEL	DELI	Yes
18813	02/05/2017	15:56:24	16:06:24	individuals[1267]	callCenterWorkers[5] : 18574	ORD	SALES	Yes
18823	02/05/2017	16:19:26	16:29:26	individuals[401]	callCenterWorkers[4] : 18573	DEL	DELI	Yes

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18819	02/05/2017	16:09:29	16:19:29	individuals[954]	callCenterWorkers[2] : 18571	ORD	SALES	Yes
18827	02/05/2017	16:26:28	16:36:28	individuals[752]	callCenterWorkers[0] : 18569	PAY	FIN	Yes
18829	02/05/2017	16:31:51	16:41:51	individuals[1508]	callCenterWorkers[1] : 18570	UNEX	FOLL	Yes
18825	02/05/2017	16:24:59	16:34:59	wholesalers[15]	callCenterWorkers[5] : 18574	SET	TC	Yes
18831	02/05/2017	16:37:03	16:47:03	individuals[1780]	callCenterWorkers[2] : 18571	ORD	SALES	Yes
18839	02/05/2017	16:57:50	17:07:50	wholesalers[11]	callCenterWorkers[0] : 18569	PAY	ACCORD	Yes
18833	02/05/2017	16:45:03	16:55:03	networkDistributors[19]	callCenterWorkers[3] : 18572	ORD	SALES	Yes

Table A:10 Call Centre Log - Scenario 4

A.4.2 Sales record

SALES ORDER NUMBER	CUSTOMER NUMBER	DATE	ITEMS	QUANTITY	PRICE	WARRANTY TERMS	DELIVERY	SALES STAFF
5044	individuals[1008]	02/05/2017	SH24	1	60	NS	05/05/2017	salesWorkers[2] : 18579
5045	individuals[1777]	02/05/2017	SH18	1	40	NS	08/05/2017	salesWorkers[2] : 18579
5046	networkDistributors[25]	02/05/2017	NN41	125	Confidential in Commerce	24H	04/05/2017	salesWorkers[1] : 18578
5047	individuals[1916]	02/05/2017	SH20	1	40	NS	04/05/2017	salesWorkers[2] : 18579
5048	individuals[234]	02/05/2017	SH24ehk	1	80	NS	04/05/2017	salesWorkers[2] : 18579
5049	individuals[542]	02/05/2017	SH20	1	40	NS	04/05/2017	salesWorkers[2] : 18579
5050	individuals[1841]	02/05/2017	SH24ehk	1	80	NS	05/05/2017	salesWorkers[2] : 18579
5051	individuals[1456]	02/05/2017	SH20	1	40	NS	05/05/2017	salesWorkers[2] : 18579
5052	individuals[637]	02/05/2017	SH24	1	60	24H	05/05/2017	salesWorkers[2] : 18579
5053	networkDistributors[14]	02/05/2017	SH20	125	Confidential in Commerce	24H	05/05/2017	salesWorkers[1] : 18578
5054	individuals[1909]	02/05/2017	SH20	1	40	NS	04/05/2017	salesWorkers[2] : 18579
5055	individuals[1494]	02/05/2017	SH18	1	40	NS	08/05/2017	salesWorkers[2] : 18579
5056	individuals[1691]	02/05/2017	SH24ehk	1	80	NS	05/05/2017	salesWorkers[2] : 18579
5057	individuals[1143]	02/05/2017	SH18	1	40	NS	05/05/2017	salesWorkers[2] : 18579
5058	individuals[374]	02/05/2017	SH20	1	40	NS	04/05/2017	salesWorkers[2] : 18579
5059	networkDistributors[13]	02/05/2017	NN28	125	Confidential in Commerce	24H	08/05/2017	salesWorkers[1] : 18578
5060	individuals[1797]	02/05/2017	SH24ehk	1	80	NS	08/05/2017	salesWorkers[2] : 18579
5061	individuals[1663]	02/05/2017	SH24ehk	1	80	NS	08/05/2017	salesWorkers[2] : 18579
5062	individuals[866]	02/05/2017	SH20	1	40	NS	05/05/2017	salesWorkers[2] : 18579
5063	individuals[1091]	02/05/2017	SH20	1	40	NS	08/05/2017	salesWorkers[2] : 18579
5064	individuals[1639]	02/05/2017	SH20	1	40	NS	08/05/2017	salesWorkers[2] : 18579
5065	individuals[76]	02/05/2017	SH24ehk	1	80	NS	04/05/2017	salesWorkers[2] : 18579
5066	networkDistributors[9]	02/05/2017	NN28	125	Confidential in Commerce	24H	04/05/2017	salesWorkers[1] : 18578
5067	individuals[1543]	02/05/2017	SH24ehk	1	80	NS	08/05/2017	salesWorkers[2] : 18579
5068	networkDistributors[15]	02/05/2017	NN28	125	Confidential in Commerce	24H	05/05/2017	salesWorkers[0] : 18575
5069	networkDistributors[24]	02/05/2017	NN17	125	Confidential in Commerce	24H	05/05/2017	salesWorkers[1] : 18578
5070	individuals[243]	02/05/2017	SH20	1	40	NS	08/05/2017	salesWorkers[2] : 18579
5071	individuals[1267]	02/05/2017	SH24	1	60	NS	08/05/2017	salesWorkers[2] : 18579
5072	individuals[954]	02/05/2017	SH20	1	40	NS	08/05/2017	salesWorkers[2] : 18579
5073	individuals[1780]	02/05/2017	SH20	1	40	NS	05/05/2017	salesWorkers[2] : 18579

5074	networkDistributors[19]	02/05/2017	NN28	125	Confidential in Commerce	24H	08/05/2017	salesWorkers[1] : 18578

Table A:11 Sales record - Scenario 4

A.4.3 TS record

SUPPORT CALL NUMBER	CALL DATE	CALL TIME	CUSTOMER NUMBER	ITEM	TS ENGINEER	ISSUE	RESOLVED
3300	02/05/2017	9:14:50	individuals[346]	SH24	technicalSupportWorkers[1] : 18577	PROD	Yes
3301	02/05/2017	9:42:37	networkDistributors[14]	NN41	technicalSupportWorkers[0] : 18576	USER	Yes
3302	02/05/2017	9:57:18	individuals[1827]	SH20	technicalSupportWorkers[1] : 18577	USER	Yes
3303	02/05/2017	10:18:29	individuals[1450]	SH20	technicalSupportWorkers[1] : 18577	USER	Yes
3304	02/05/2017	10:50:57	individuals[480]	SH24ehk	technicalSupportWorkers[1] : 18577	USER	Yes
3305	02/05/2017	11:13:53	individuals[265]	SH24ehk	technicalSupportWorkers[1] : 18577	PROD	Yes
3306	02/05/2017	11:31:59	wholesalers[2]	SH24ehk	technicalSupportWorkers[1] : 18577	PROD	Yes
3307	02/05/2017	11:52:03	individuals[710]	SH24ehk	technicalSupportWorkers[1] : 18577	USER	Yes
3308	02/05/2017	12:17:10	individuals[1199]	SH24ehk	technicalSupportWorkers[1] : 18577	PROD	Yes
3309	02/05/2017	14:11:17	individuals[121]	SH24ehk	technicalSupportWorkers[1] : 18577	PROD	Yes
3310	02/05/2017	14:41:48	individuals[220]	SH20	technicalSupportWorkers[1] : 18577	USER	Yes
3311	02/05/2017	15:01:38	individuals[557]	SH20	technicalSupportWorkers[1] : 18577	PROD	Yes
3312	02/05/2017	15:55:35	individuals[726]	SH24ehk	technicalSupportWorkers[1] : 18577	USER	Yes
3313	02/05/2017	16:34:59	wholesalers[15]	SH24	technicalSupportWorkers[1] : 18577	USER	Yes

Table A:12 TS record - Scenario 4

Appendix B Data analysis Scenario 1

B.1 The dataset

The generated dataset for the first scenario contains data from the Call Centre, Sales and Technical Support departments for the month of May 2017.

The Excel file has three sheets; one for the Call Centre log file, one for the Sales record and one for the Technical Support record. Table B1 shows the variables of each sheet.

Call Centre log file	Sales record	TS record
Call record number	Sales order number	Support call number
Call date	Customer number	Call date
Call time	Date	Call time
End call time	Items	Customer number
Customer number	Quantity	Item
Call handler	Price	TS engineer
Issue	Warranty terms	Issue
Resolution	Delivery	Resolved
Closed at call	Sales staff	

Table B:1 Dataset structure

B.2 Call Centre report

The analysis of the call centre will be divided by call times, issues, customers, and workers.

B.2.1 Call times

Figure B1 shows the answered call distribution over time. The days without calls correspond to the weekends and holidays, when the call centre staff are not working. At first glance, it cannot be seen any pattern in the distribution.
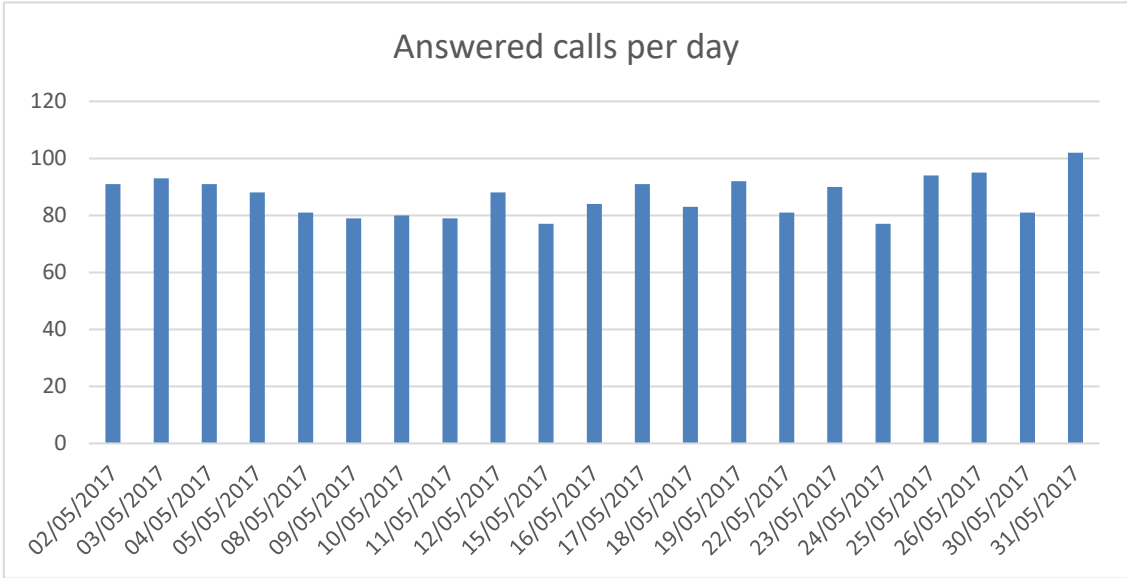
Figure B:1 Answered calls distribution over time

Figure B2 shows the call distribution along one day, the 2nd May 2017.
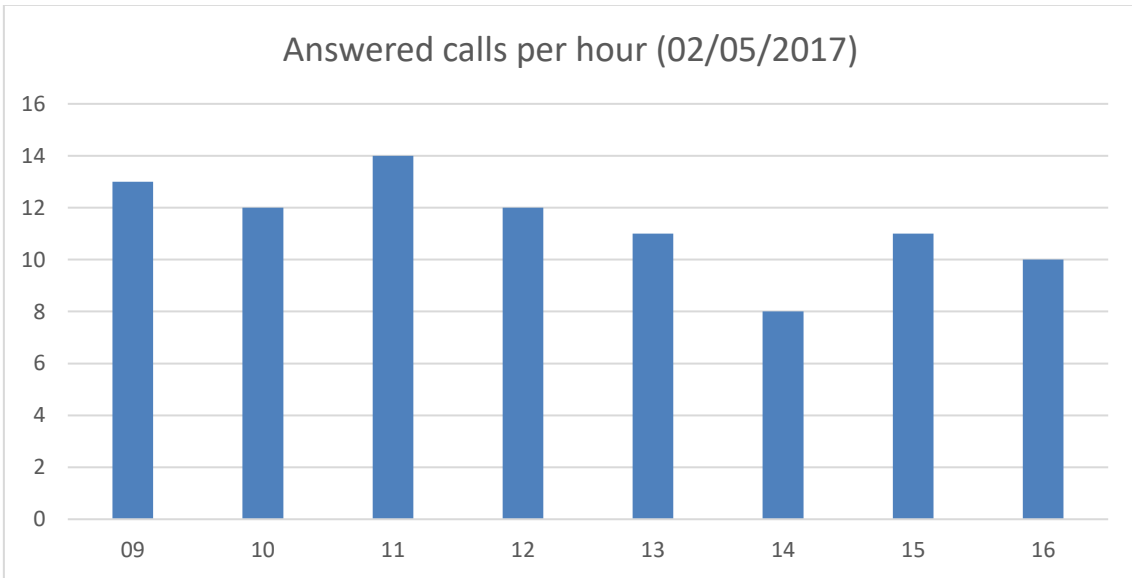
Figure B:2 Answered calls distribution 2nd May

To see if there is a pattern in the distribution of calls along the day, another day will be analysed, Figure B3. It is clear that there is not a pattern in the call distribution.
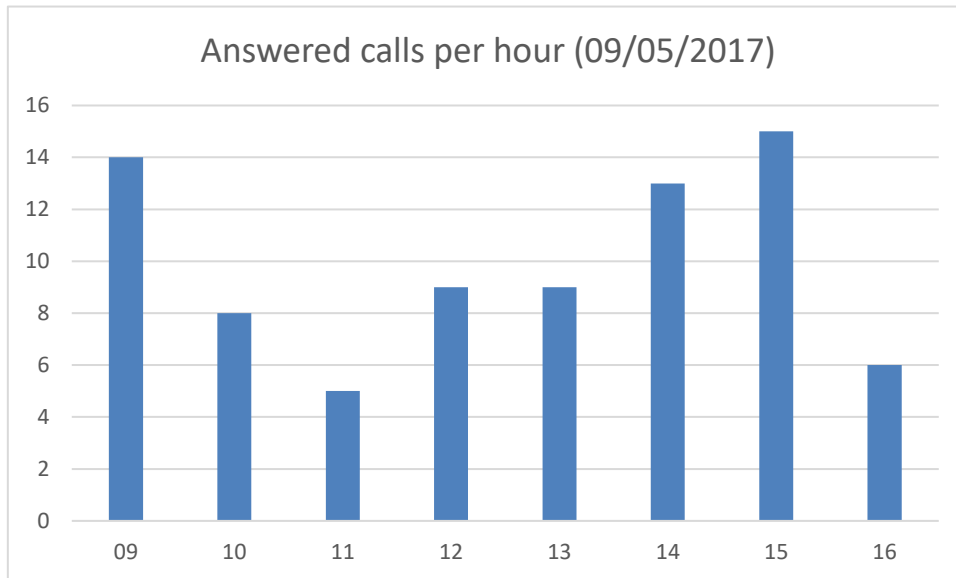
Figure B:3 Answered calls distribution 9th May

B.2.2 Issues

Figure B4 shows the calls grouped by issues that the Call Centre received. The most common issue is ORD, followed by PAY.
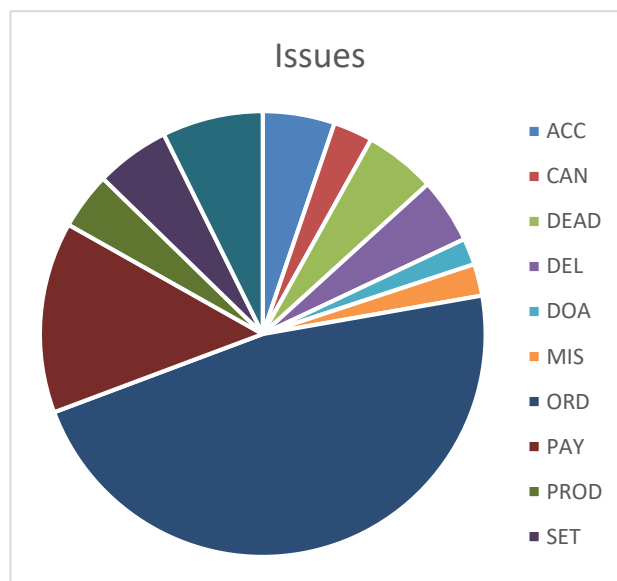
Figure B:4 Call Centre issues

Table B2 presents the number of calls for each issue and its resolution. The most common resolution is SALES, which corresponds to the most common issue ORD.

ACC	**95**
ACCORD	22
FIN	73
CAN	**52**
CANCEL	8
SUB	44
DEAD	**94**
TC	94
DEL	**86**
DELI	86
DOA	**35**
BSPT	32
RETN	3
MIS	**42**
PSPT	35
RETN	7
ORD	**855**
ORDER	273
SALES	582
PAY	**252**
ACCORD	113
FIN	139
PROD	**75**
PTREE	13
TC	62
SET	**98**
SSPT	9
TC	89
UNEX	**133**
FOLL	133

Table B:2 Call centre issues - resolutions

B.2.3 Customers

There are four types of customers: individuals, network distributors, wholesalers and Longtau teams. However, Longtau teams do not call to the Call Centre, but directly to the corresponding department.

Instead of analysing the average number of calls per customer, it makes more sense to analyse it depending on the type of customer, as their needs are different. Table B3 shows the average calls per customer type and the total sum of calls per customer type.

	Number of customers	Average calls per customer	Sum of calls
Individuals	2000	1.4	1463
Network distributors	35	5.4	188
Wholesalers	20	6.3	126

Table B:3 Calls per customer type

Although individual's customers are the ones who make less calls on average, their sum of calls is the highest as they represent the biggest collective of customers. The same thing happens to the network distributors in comparison to the wholesalers.

Also, there are 40 calls without customer identification. The reason of this is that some people may call the call centre without buying anything previously, just asking for information, so they are not recorded in the system yet.

B.2.4 Call Centre staff

Figure B5 presents the percentage of calls answered by each worker. The worker 18573 processed the maximum number of calls (320 calls, 18%), whereas the worker 18574 processed the minimum number of calls (290, 16%). Therefore, as the difference is not significant, the workload is balanced between the call centre staff.
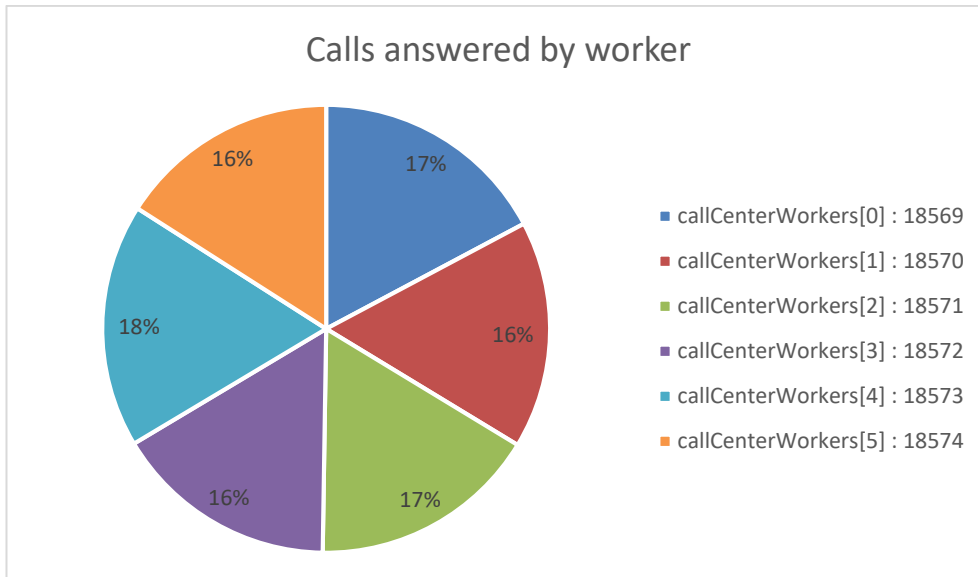
Figure B:5 Calls answered by worker

B.3 Sales report

For the sales report, the analysis will be divided by product, customers and workers.

B.3.1 Product

Figure B6 shows the quantity sold per item type. It can be seen that the most sold product is the SH24ehk. Furthermore, SOHO products represent the 83% of the total sales.
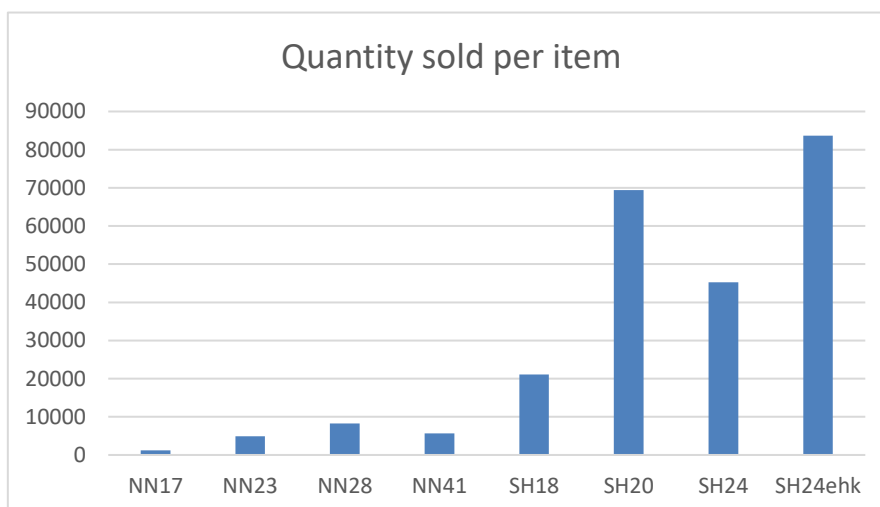
Figure B:6 Quantity sold per item

Regarding warranty terms, Figure B7 presents the warranty type per product type. Only Network Switches (NN) products have 24H warranty. The rest of SOHO products have LM, NS and RMA warranty. Analysing these products and their warranty, it can be appreciated that the warranty type depends on the customer type; NS for individuals, LM for wholesalers and RMS for Longtau teams.
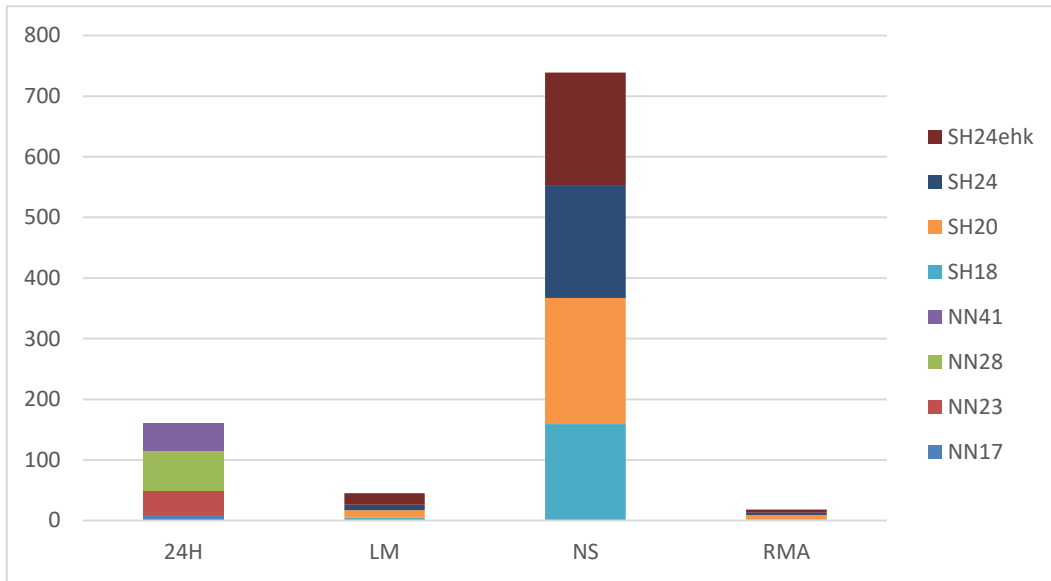
Figure B:7 Warranty type per item

B.3.2 Customers

Table B8 presents some metrics about the different customer types. Whereas individuals customers are the ones that place more orders (739), they are the ones that buy less quantity. However, Longtau teams and wholesalers place less orders but buy more quantity as their average quantity per order is much higher. This means that they generate little work but lot of revenues.

	Av. orders	Total orders	Av. quantity	Total quantity
Individuals	1.2	739	1.2	739
Longtau teams	3.6	18	12240	61200

| Network distributors | 4.6 | 160 | 571.4 | 20000 |
| Wholesalers | 2.6 | 45 | 9264.7 | 157500 |

Figure B:8 Sales per customer type

B.3.3 Workers

Figure B9 presents the workload of each worker. It can be seen that worker 18579 is the one that has the highest workload, followed by worker 18579 and 18575. There is a percentage of 29% that represents web sales. Web sales do not require any sales worker.
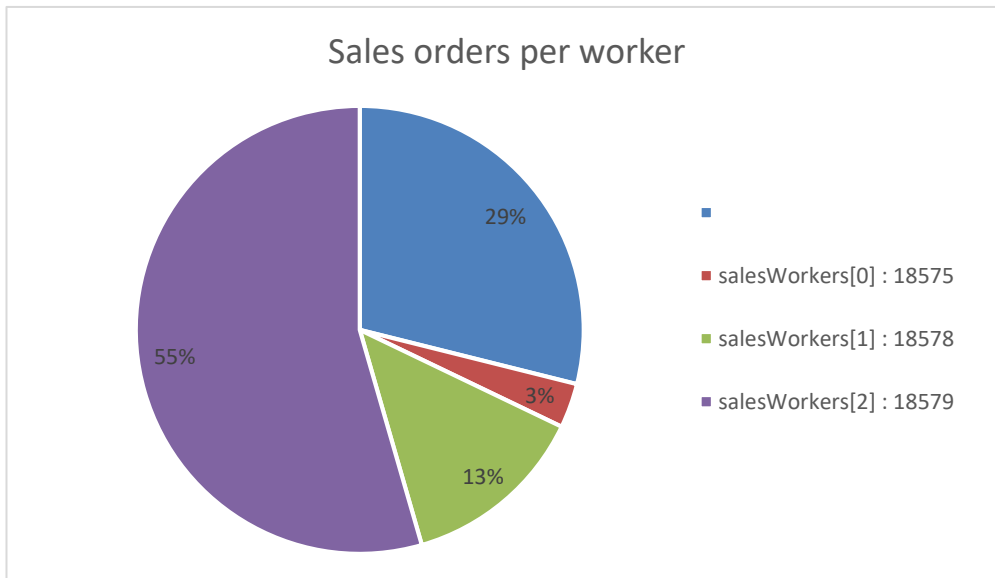
Figure B:9 Sales orders per worker

It is clear that the workload is not balanced between the team members. Figure B10 shows the sales orders per worker and item type. Whereas worker 18579 only processes orders of SOHO products, workers 18575 and 18578 process orders of NN products. Therefore, it seems that they work less because they do not have more work to do, and not because their productivity is lower. It can be concluded then that the workload is not balanced.
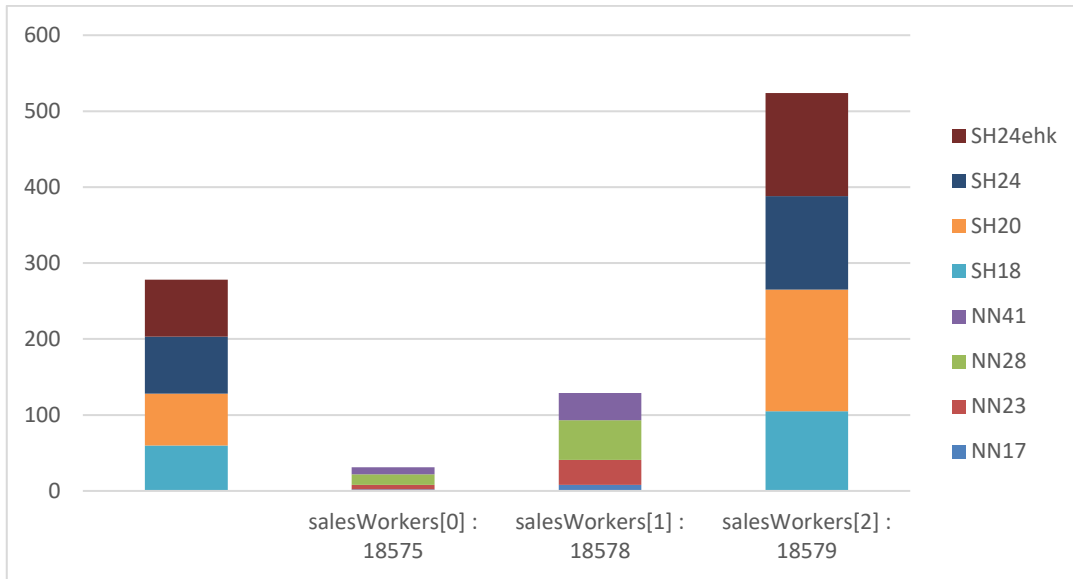
Figure B:10 Sales orders per worker ant item

Finally, Figure B11 presents the sales orders distribution along time. An important fact is that there are sales orders every day, including weekends and holidays. Figure B12 shows sales orders processed by each team member, but they do not work during weekends and holidays. Therefore, all the sales placed during holidays are web sales.
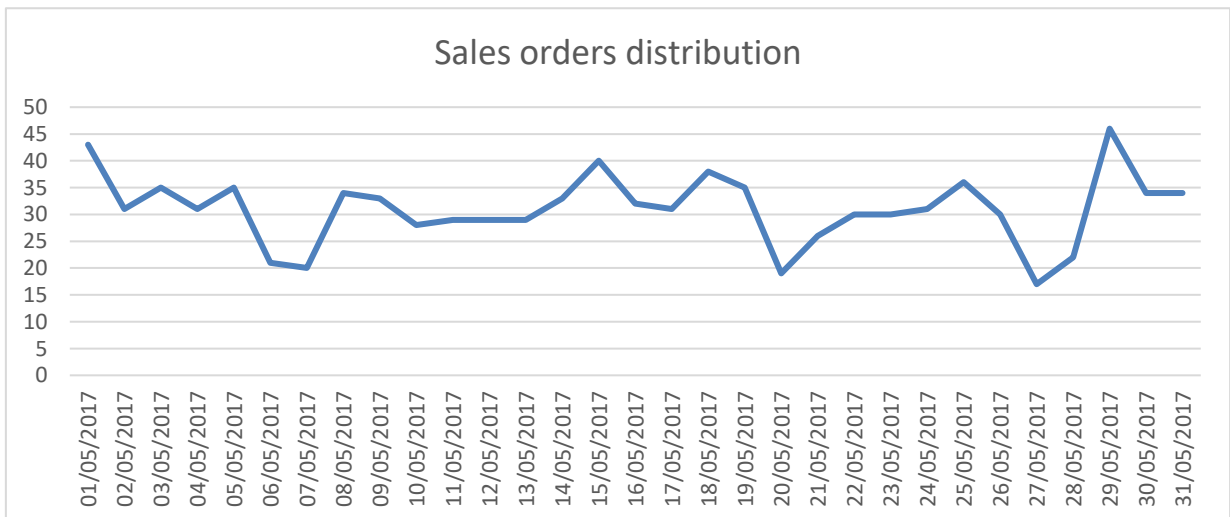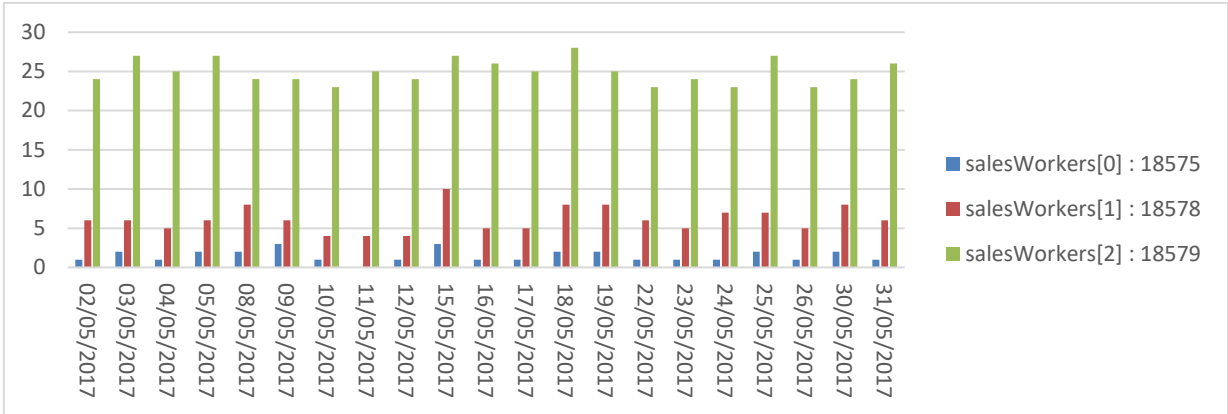

Figure B:11 Sales orders distribution

Figure B:12 Sales orders per worker

B.4 Technical Support report

The analysis of the Technical Support department will be divided by product, workers and call times.

B.4.1 Product

Figure B13 shows the percentage of support calls per product type. It can be seen that the majority of the calls correspond to SOHO products.
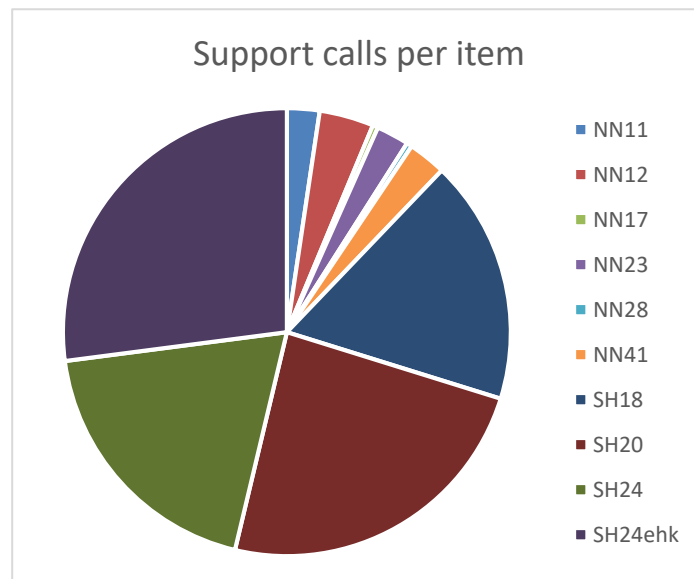
Figure B:13 TS call per item

An important point to consider is that there were more sales of SOHO products, so it makes sense that there are more SOHO technical issues.

Figure B14 shows the number of support calls per item type and issue. As it has been said previously, SOHO products are responsible for the majority of the calls. Besides, the majority of the issues are USER (for both NN and SOHO products), this means that customers need more help or training in the product use.
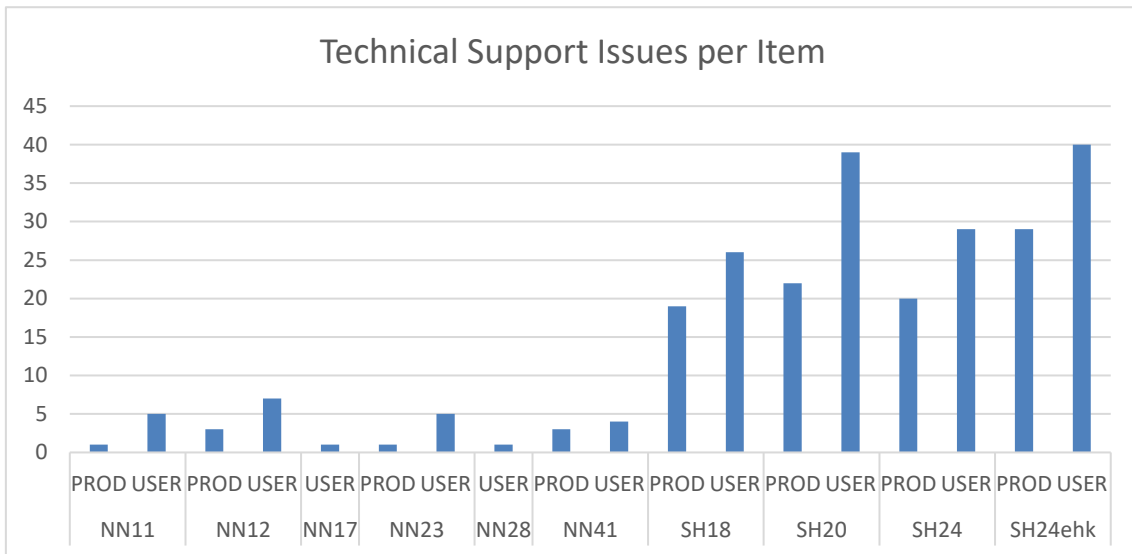
Figure B:14 TS call per item and issue

B.4.2 Workers

Figure B15 shows the percentage of technical support calls processed by each team worker. Clearly, the workload is not balanced and worker 18577 works more than worker 18576.
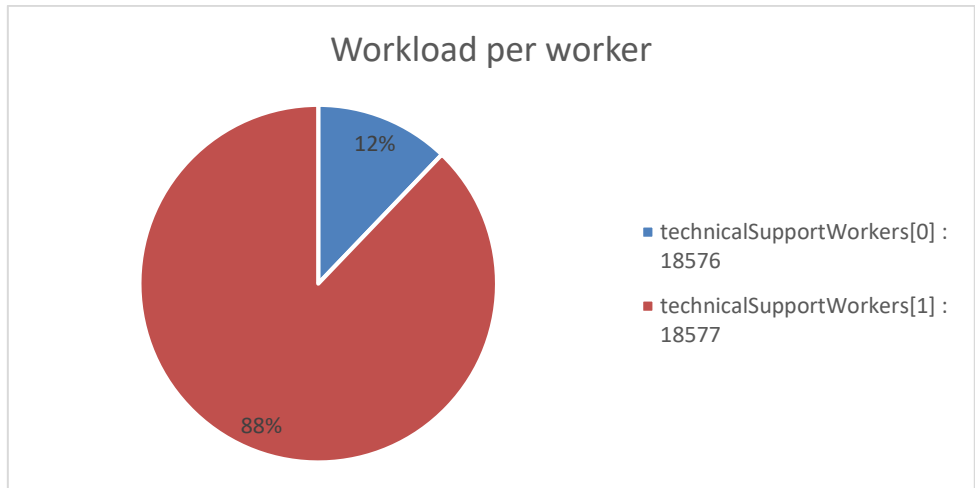
Figure B:15 TS calls per worker

To understand if it is a problem of the workload or a productivity problem, Figure B16 presents the calls processed per worker and item type. Worker 18576 is responsible for NN products, while worker 18577 is responsible for SOHO products. Again, as there were more SOHO sales, it is reasonable to think that there is a problem in the workload balance, instead of a productivity problem of worker 18576.
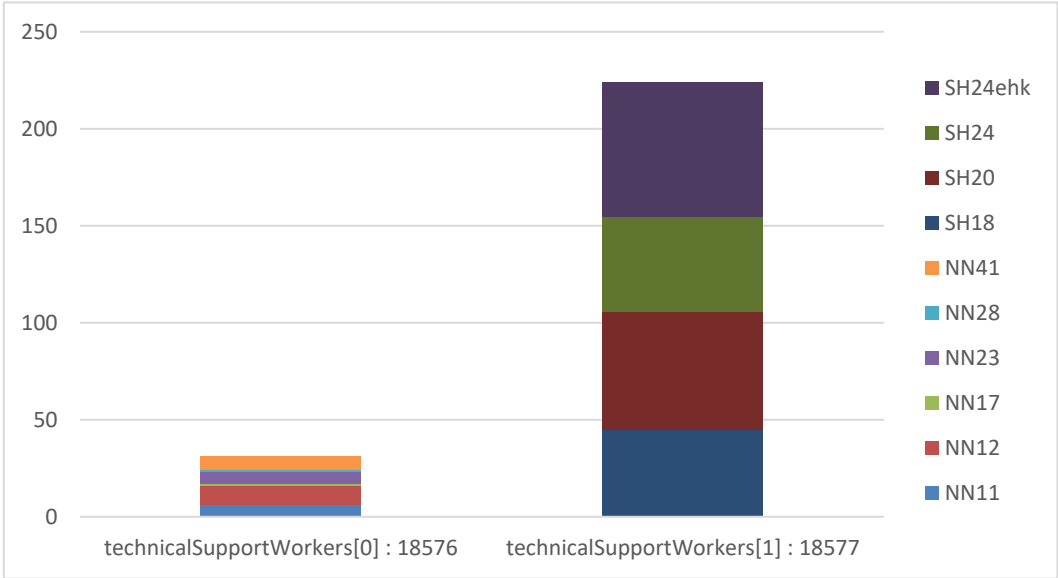

Figure B:16 TS calls per worker and item

B.4.3 Call times

Figure B17 shows the calls distribution during the month. It can be seen that the TS staff do not work during weekends and holidays. Figure B18 shows the calls distribution along the day, and it can be deduced that TS staff work from 9.00 to 17.00.
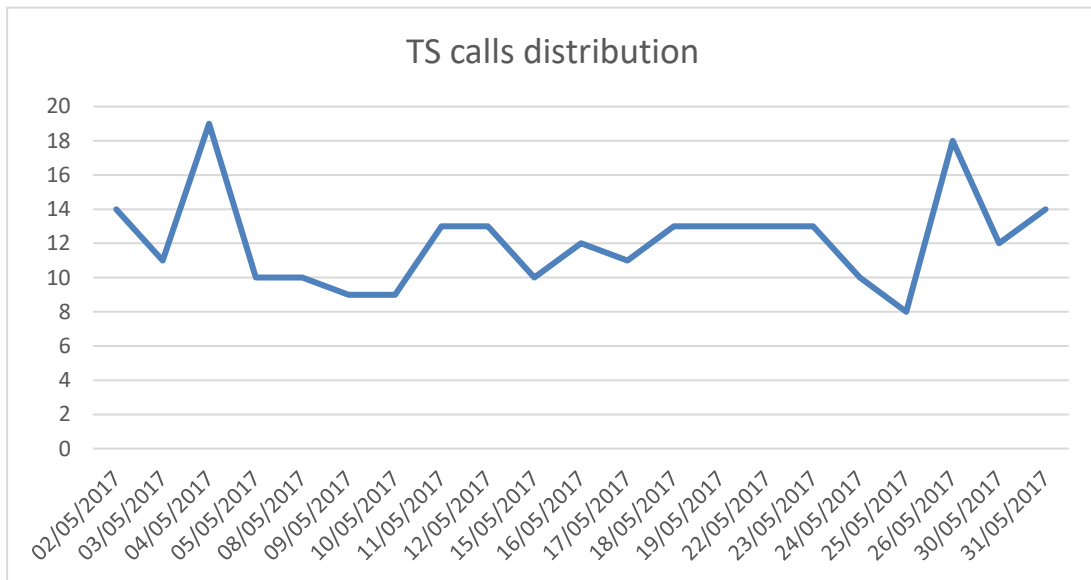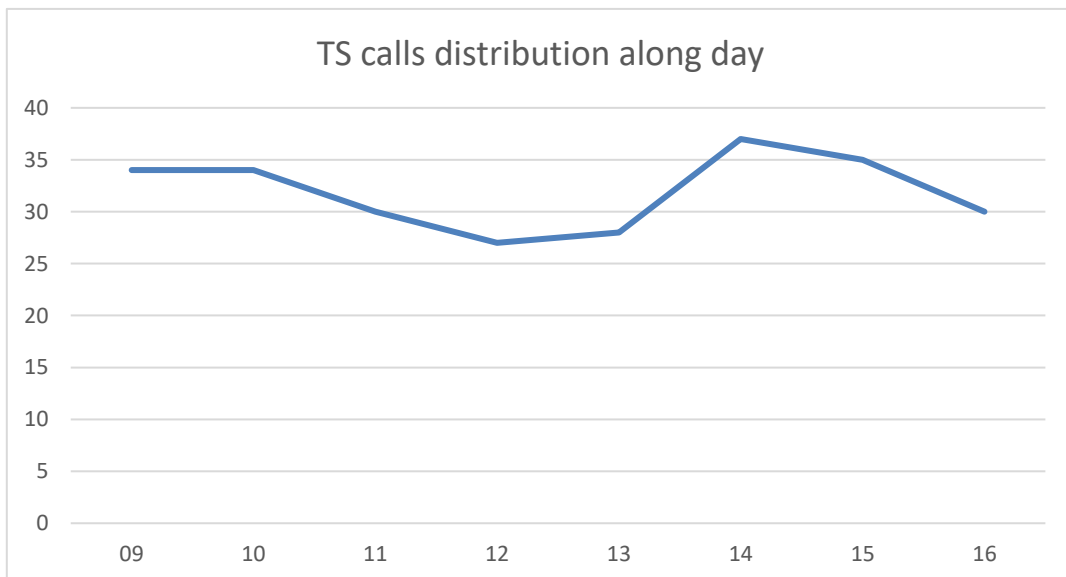

Figure B:17 TS calls monthly distribution

Figure B:18 TS calls daily distribution