SPATIAL ENTERPRISE PLANNING – BUSINESS GEOGRAPHIC PROCESSING

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June, 2020

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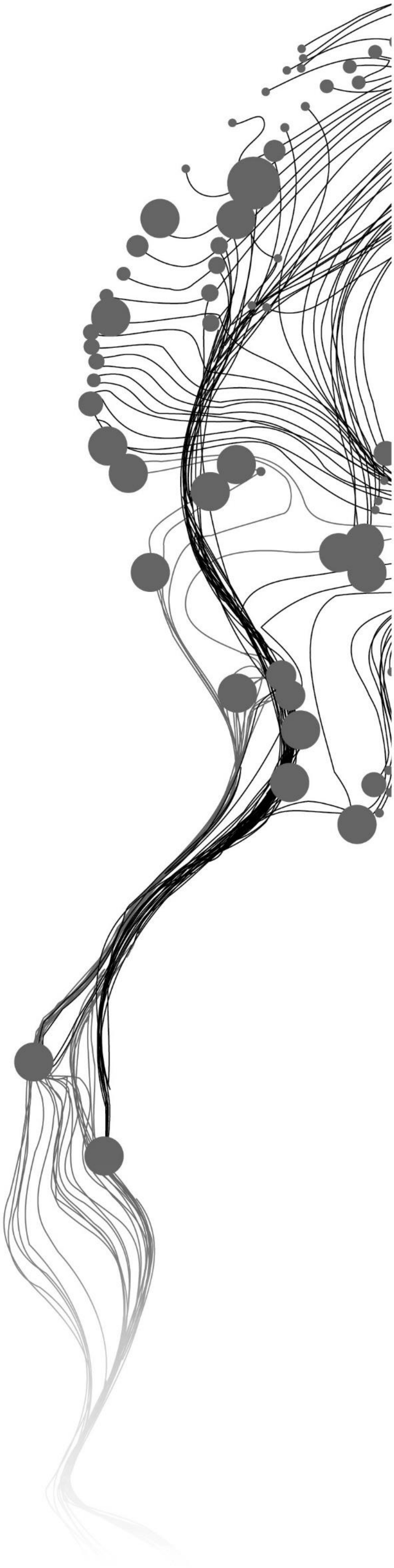

SPATIAL ENTERPRISE PLANNING – BUSINESS GEOGRAPHIC PROCESSING

TOMIWA EUNICE, OWOEYE
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Thesis submitted to the Faculty of Geo-Information Science and Earth Observation of the University of Twente in partial fulfilment of the requirements for the degree of Master of Science in Geo-information Science and Earth Observation.
Specialisation: Geoinformatics

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ABSTRACT

With the use of GIS technology, the insurance business process has evolved from just digital filing of forms for insurance processes to geo-targeted processes and decision making with geospatial techniques. Making use of analytics and resource planning systems to improve the determination of premium payable and increase efficiency in claim management are examples of these techniques.

Using a spatial enterprise resource planning system (ERP) helps achieve the automation and optimisation of insurance business processes (BP), especially in critical processes like premium calculation and claims management. This research gives a detailed approach to the integration of location intelligence (LI) into the ERP system developed for insurance BP. It also enumerates the several benefits achieved from this integration, one of which involves providing an insurance organisation with a competitive edge amongst organisations.

The ERP system ERPNext was selected for the implementation of this integration due to its market-leading creative and dynamic environment for developing individual applications, with Python as its core, the use of MariaDB as its database and the ease of extending an existing insurance application system using Representational State Transfer API (REST API).

Furthermore, the integration of the location factor into the insurance application built on ERPNext gave more insights in the influence of the location of the policyholder on the amount of premium payable and the frequency at which claims are submitted. With proceedings from this research work, insurance stakeholders can make improved decisions regarding all the insurance BP within the organisation.

Keywords: *Spatial Enterprise Planning, Location Intelligence, Enterprise Resource Planning System, Business Processing.*

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1. INTRODUCTION

1.1. Background

A business process can be seen as a workflow and comprises of a set of one or more linked procedures or activities, which when collectively used aids the realization of business objectives. Significant factors that drive change in business processes have recently included innovations in computation and effective communication. As a result, business processes have become more complex and rely on sophisticated information systems (Van Der Aalst, 2013). Business processes typically traverse quite a few units within a company and include activities carried out by different personnel; this implies a substantial complexity of designated tasks and demands for an optimized and automated approach. Geographic information system (GIS) can be used as this approach, as businesses contain spatial components like the location of where the businesses have been conducted and the customers been served, all of which can be used in business processes. Connecting GIS with business processes can provide optimization to business workflows (Mendling & Simon, 2006). A sound GIS system can process geographic data from various sources and integrate it into any form, which can then be ingested by business workflows. GIS applications are embedded in some activities such as verifying customer addresses, tracking inventory, and cross-checking customer information with their actions. From routinely performing work-related tasks to scientifically exploring the complexities of our world, GIS applications give people the geographic advantage to become more productive, more aware and more responsive of planet Earth (Patel, 2008). Simultaneously, a GIS system offers a set of technological tools that enables business stakeholders to make geographically informed decisions by studying the often close bonds between with time and space (Biswaketan, Rajesh, & Raghunathan, 2010). To achieve a shorter process for integrating new applicants into the insurance organization (i.e. onboarding process), consistent response to claim requests, better claims management and to improve the process involved in the assessment of each applicant risks before determining the fee payable for the risk coverage (i.e. underwriting processes), scholars alongside software vendors have proposed the integration of GIS and enterprise resource planning (ERP) technologies in business organisations (Aydin & Sarman, 2002).

An ERP system, like most enterprise systems (ES), is an integrated information system that assists organisations in the integration of business processes and effective management of resources (Cruz-Cunha, 2010). An ERP system consists of function-specific units designed to interact with the other units, which are utilized based on the best methods that fit the needs and technical capabilities of an organisation (Patel, 2008). There are several phases involved in the amalgamation of an ES with business processes, which grouped into four creates the (1) adoption phase, (2) implementation phase, (3) usage and maintenance phase and (4) the enhancement and integration phase (Ahmad & Mehmood, 2016). The use of an enterprise system proffers a solution for the enhancement such as resources allocation and management needed in business processes especially in the insurance department; one of which is executed with the integration of an ES with business processes as seen in Figure 1 below, thus providing services at little or no cost which helps to promote the businesses in the organisation (Ahmad & Mehmood, 2016). Current practice in business process workflows often includes data silos to support single business processes that were developed in isolation. There is therefore a need for data harmonisation (Tarhini, Ammar, Tarhini, & Ra'ed Masa'deh, 2015).

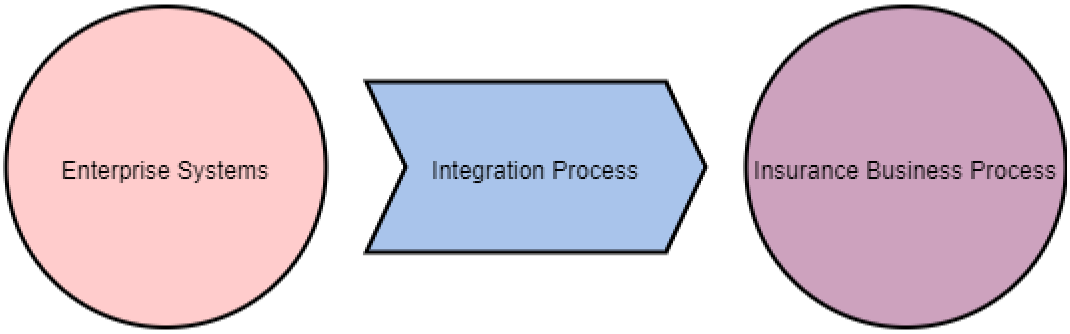

Figure 1: Business Process Optimization

1.2. Research Justification

In business processes, there are some components of an ES like the ERP system that have intrinsically some geographic context attached to it, for example, a customer's address, land parcel or the location of assets. This geographic attachment can be used to inform the decision-making process in an organisation when the analysed results obtained from the data are used. Spatial information such as the demographic, economic and geographical data contributes to the location analytics which aids the discovery of the patterns, risks and opportunities present in the business data, which will otherwise go unnoticed using tabular analysis. With the use of GIS applications as a tool which enables the tracking and visualization of business data such as embedded maps into dashboards and displays, the integration of spatial enterprise systems and business process workflow can be implemented. Studies have shown that the use of GIS tools in business processes enables organisations to make geographically informed decisions (Biswaketan et al., 2010; Hosseini & Hosseinpoor, 2015). This collaboration between GIS and ES in the business process offers competitive advantages to any business initiative especially in marketing areas seeing that harmonised data makes it easier to perform real-time analysis, increase the speed in which data is processed and general improvements in analytics done on integrated databases amongst others (Columbus, 2018).

The use of ES in insurance is beneficial to the insurance organisation once there is an integration of geographic data services into the ES; these benefits are discussed in detail under section 2.2. Examples are in the reduction of invalid claims, better establishment of premiums and development of policies which are beneficial and befit the customers. The inclusion of geographic data services such as services with location information enhances business intelligence giving a geographic dimension to the data generated by the business. This value-added geographic data service is termed location intelligence (Loshin, 2013; SAP HANA, 2016). Location intelligence (LI) as described by Loshin (2013) can be used to inform operational and analytical routines, workflows and decision-making in a business organisation, thus reducing expenses, increasing revenues as well as improving productivity and fulfilment for both customers and business owners. According to Columbus (2018), LI is considered a substantial part of the success and the improvement of revenue growth strategies, and its use has been recorded for industries and enterprises in general. In the insurance industry, there are damages incurred by insurers due to the lack of attention and incomprehension of the risks posed within their policy coverage areas. However, with an LI- enabled system, insurers are able to (Hosseini & Hosseinpoor, 2015):

- Assess marketing prospective through geo-targeted advertisement
- Provide accurate and feasible analyses thereby, improving decisions made
- Increase competitiveness due to accurate premium pricing
- Increase organizational productivity and profits
- Assess and manage risks based on the accurate analysis
- Manage and assess claims processes ensuring customer satisfaction

Business processes, when organised with LI, provides integration of all components, i.e. ES, ERP and workflow management (WM) as supported with GIS workflows, as shown in Figure 2 below. The figure illustrates how the insurance business process workflow is optimized by plugging into the GIS workflow components at several BP stages, since the basis of insurance is to cover risk and having spatial information about the customer enables a better risk analysis. The integration of LI into insurance business processes allows for enhanced data visualization, optimized insurance business processes, the development of bespoke products and solutions and geo-targeted advertisement (Hosseini & Hosseinpoor, 2015).

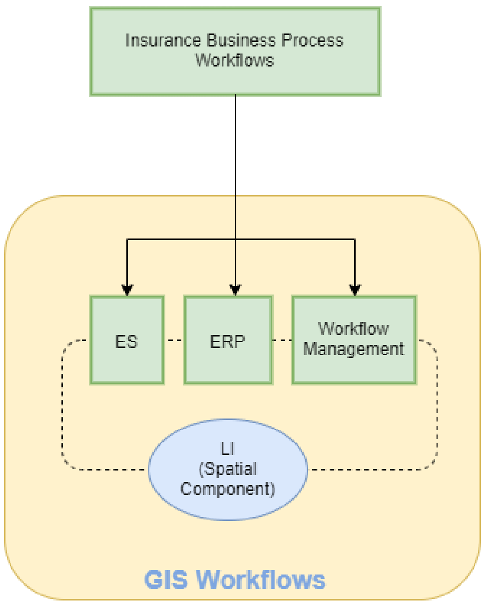

Figure 2: Integration of Location Intelligence With ERP Systems for Insurance Business Process

1.3. Research Problem

As discussed above, the present problems in business workflows can be qualified as data harmonisation and optimization problems. The challenges experienced during the integration of the GIS enterprise systems (ES) with the business process (BP) include the involvement of financial and human resources, comprehensive and risky strategies and high cost in time during the implementation stage. Some ES implementations have been categorized as either over-budgeted for or experienced delays at the implementation stage with some few cases of under-delivered benefits (Ahmad & Mehmood, 2016; AlQashami & Mohammad, 2015).

Due to the limited use of LI in the insurance BP, this research project aims to optimize the significant business workflows involved in the insurance industry by integrating into the insurance BP, geographic data services like LI, for the automation and optimization of the BP.

1.4. Research Objectives and Questions

1.4.1. Research Objectives

The main research objective involves the integration of a spatial enterprise planning system (using LI) into the business process involved in the insurance organisation. For successful integration, the LI-enabled enterprise planning system will be assessed based on the critical success factors associated with the integration of an ES. This main objective can be further grouped into the following sub-objectives and research questions.

1.4.2. Research Questions

1. A complete overview of insurance business processes that can benefit from LI.
    - Which insurance business process is the LI factor more relevant to?
    - Who are the stakeholders involved in the insurance business process?
2. Evaluate ways to integrate both insurance BP (ES, ERP, WM) and LI.
    - What are the possible methods to connect LI with insurance business process?
    - What new benefits are obtained from the already existing business process, and how can these benefits be measured?
    - How can the optimization be measured using the selected integration method?
3. Implementation of the Integrated Business Process Workflows with LI.
    - How does LI affect the workflow of the insurance industry?
    - What are the measurable variables, and what results are derived from them?
    - Which Critical Success Factors (CSFs) must be accounted for to successfully integrate ES with the insurance business workflows?

1.5. Innovation Aimed At

The conceptual framework in Figure 3 gives an overview of the current state of the insurance business workflow process (above) and the transformed workflow implemented by this research project (below).

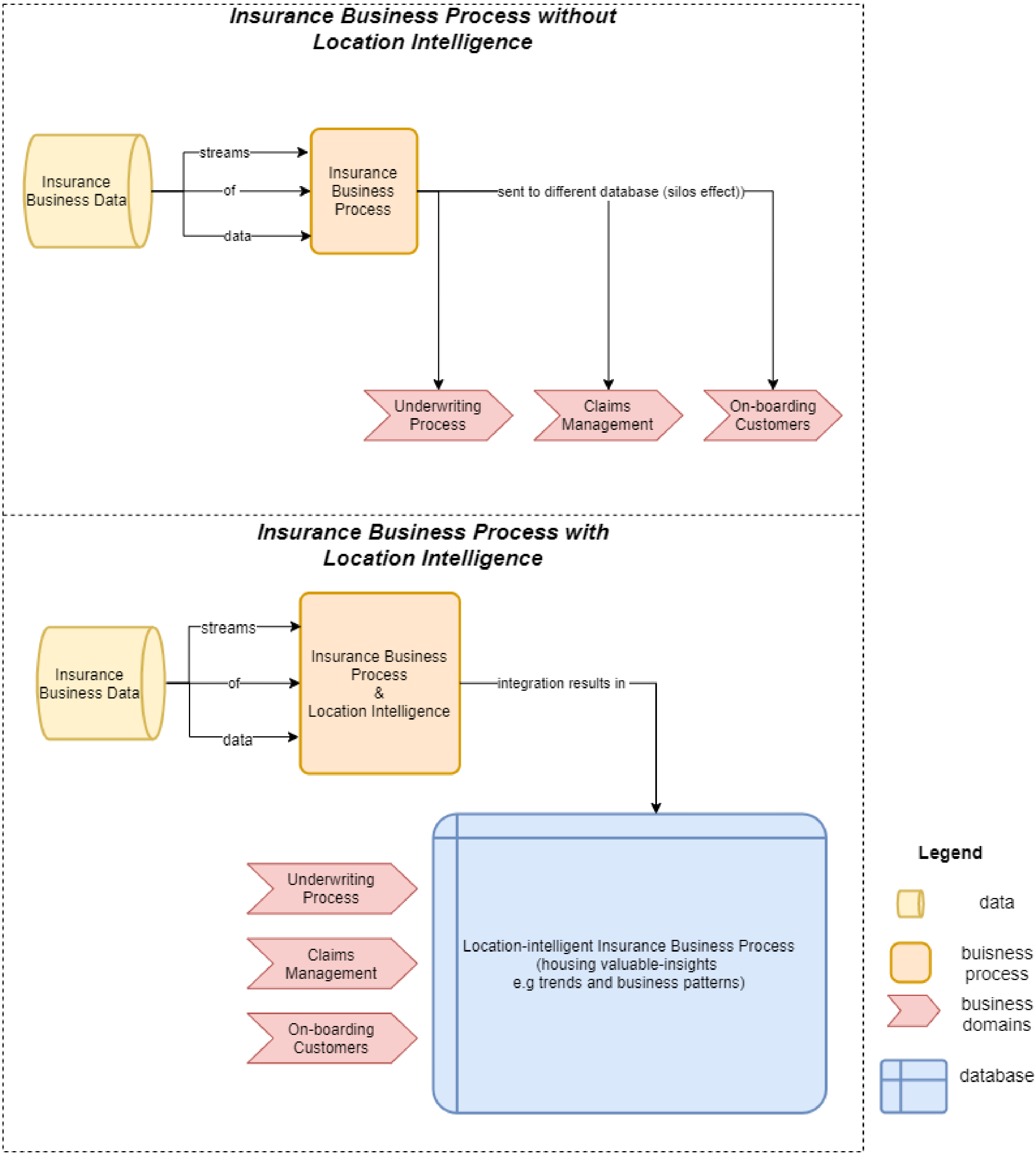

Figure 3: Conceptual Framework Showing the Impact of Location Intelligence on Insurance Business Process

Presently, business process workflows in the insurance industry across various domains such as underwriting, claims management and onboarding of customers are stored in silos data stores. The isolation of these data stores leads to duplication in data records in business data, slowing down business processes, amongst other limitations. For the optimization of these business processes, a need to harmonize the database system and subsequently integrate LI into the business workflow process is required. A harmonized database system is achieved by using an ES for business database management. With this, the integration of these insurance BP with LI framework can be realized, and then domains in the organisation can make a request to this database and get geo-located responses that already have business patterns and insights embedded in it. Examples of responses acquired from an underwriting domain are a tailor-made premium rate for customers based on their addresses in the case of property and asset insurance, in the claims management domain, there will be limited records of invalid claims (i.e. claims which have fraudulent elements to it and those that are not correctly requested by the customers) and reduction in human error made and for on-boarding customers domain there will be a possible increase in customers due to the marketing and sales of bespoke policies and premium rates rendered to each individual.

1.6. Related Works

Various business organisations have considered and also looked into the connection of the ERP systems and GIS workflows to help improve, optimize their business process and provide a potential increase in revenue with the reduction in overhead costs in the organisations. Patel (2008), cited several case studies where the use of ERP systems for workflow management and the use of GIS systems for location-based information management, better allows the business to obtain their objectives with maximum efficiency. The exploration of the integration of ES and GIS for the business process has gained more ground in the research world. According to Ahmad and Mehmood (2016), ES has been deployed to improve intracity logistics and supply performances during claim management for policyholders who have their insurance policy outside of their home country. This approach leverages the predictive modelling capabilities of the ES to improve the vital performance metrics of the supply chain – cost, time, quality, flexibility and creativeness; thereby leading to the development of sustainable logistics in such cities.

Karabegovic and Ponjavic (2014) explored the use of a geoportal interface for ES in the business process by publishing spatial data obtained from data warehouses to users, in this case, the insurance organisations who in turn makes all calculations and BPs transparent to policyholders. This geoportal allowed for more user interactivity. The data structure was more organised and included the integration of disparate data, with added spatial analytics capability, which reduced the decision cycle time and improved decision making within the insurance organisation. The use of enterprise systems for the visualization and storage of business data is not farfetched as most business data in data warehouses are often spatial. Therefore, using ES improves the intelligence of a complete information system by involving spatial extension and without using this component, analysis done with business data will be missing an essential dimension of data nature (Markovski & Gusev, 2013). Some businesses have sought to utilize a heuristic algorithm in solving problems arising as a result of the lack of spatial analytics component. Problems such as the availability of data without spatial techniques required to integrate, display and analyse to yield information that is useful for decision-makers. This algorithm allows the ES to learn by itself, with loosely defined rules attached which translates to useful information for the decision-makers within the insurance organisation (Tarantilis, Kiranoudis, & Theodorakopoulos, 2008).

Today, the use of LI as the spatial component for the business process is due to the proliferation of spatial data in the business data capture process. According to Dresner and Ericson (2016), LI ranks 12th amongst the strategic technologies and initiatives for business intelligence. The implementation of LI in the business process cuts across various business industries from construction and manufacturing industries to the aviation and financial industries. For example, in the development of a webGIS solution for the planning and construction of airport infrastructure, (Ponjavic & Karabegovic, 2019) incorporated LI in their implementation. This implementation was achieved using a functional webGIS solution built on the LI infrastructure integrated with the management technologies for the airport company. The solution helped the organisation monitor spatial changes in near real-time, offered a complete solution for presenting and sharing business spatial data through various departments in the company. It also provided spatial visualizations of ideas and plans with location conscious decisions been made. Though several authors have been able to identify the benefits of using both enterprise systems and GIS systems, very few have been successful in the integration of these systems due to the complexity involved (Integration of GIS and SAP – Improves Business Processes, 2012; Treiblmayr, Scheider, Krüger, & von der Linden, 2012). Hence, a knowledge gap exists which has forestalled the exploitation of the benefits such integration offers.

According to Cruz-Cunha (2010), a successful ES integration is said to be achieved when the organisation can better perform all its operations and when the integrated information system can support the performance increase of the company. There is also a methodology of evaluation called the "six imperatives" which has been used for ERP system evaluation and can be adopted here, with the methodology based on Information Systems Functional Scorecard developed by Chang, Jerry Cha-Jan & King, William, (2005). Criteria will be based on system performance, information effectiveness and service performance.

1.7. The Organisation of the Thesis

1.7.1. Research Method

The research framework, as shown in Figure 4 below, provides a summary of the methodology by which this research will be carried out. The research started with a literature review on current business processes and the strategies utilized for optimization together with the GIS workflows in place for leveraging the spatial information contained in business data. From the literature review, the relevant business process (i.e. insurance business process) which required the integration of LI was considered as the case study and used for implementing the integration to improve the optimization of the significant insurance business processes.

Literature Review

During the inception of the research exploration and investigation of various types of business processes and GIS workflows were done using literature found. On selecting the insurance business process for the case study, several factors, such as; spatial aspect, availability of data and novelty method for integration, relevant stakeholders were considered. Since the insurance industry was selected as the case study, the business processes in this review are therefore limited to this industry. Undergoing this review provided answers to the research questions listed under the first sub-objective of this project.

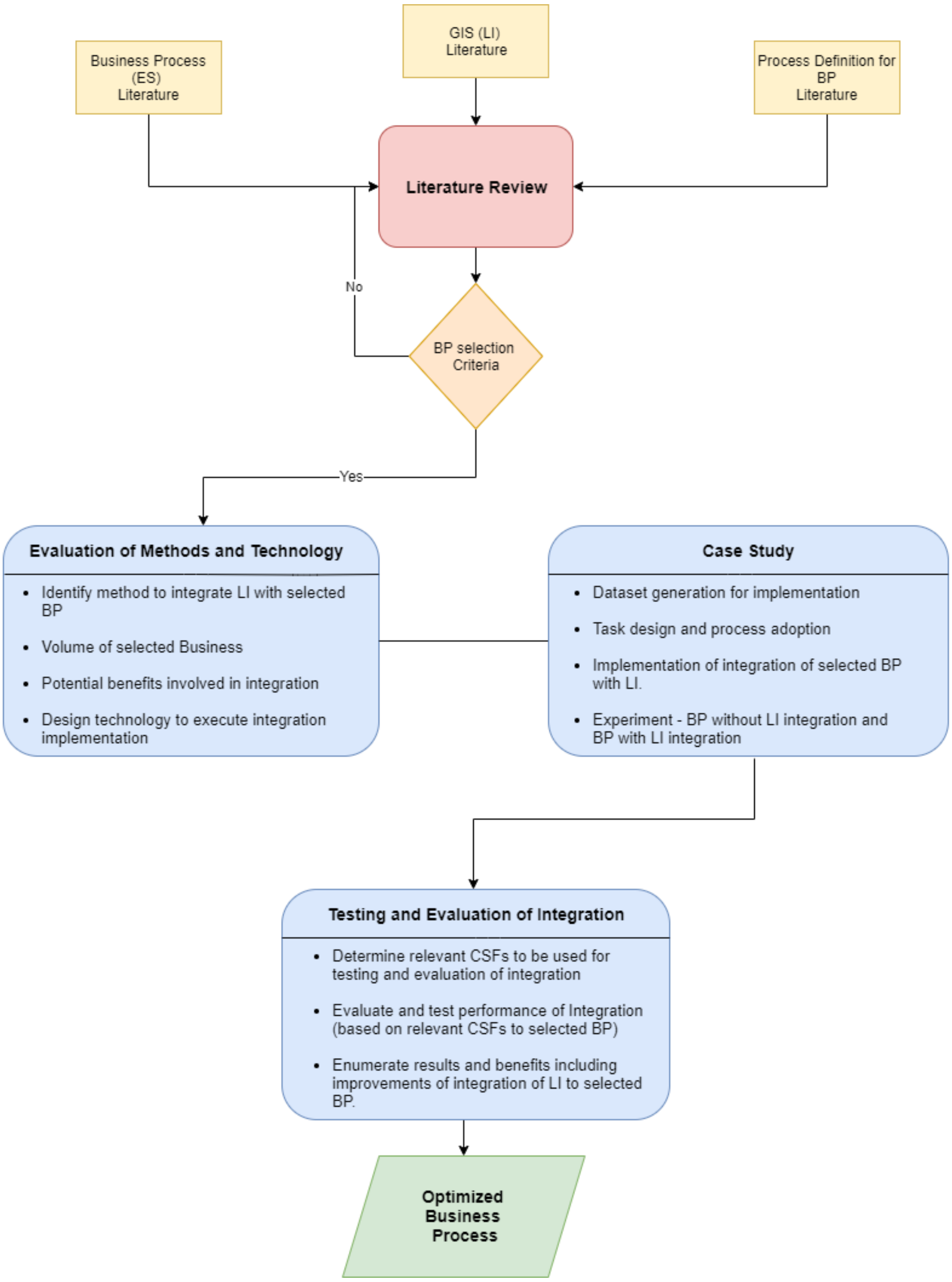

Figure 4: Research Framework on Methodology

Evaluation of Methods and Technology

After the literature study and exploration of methods and techniques used for spatial enterprise system development, the ideal method for integrating LI into insurance BP was selected. The method selected aimed to enable organisations to discover the relationship and further benefits in exploiting the understanding between the corporate data and location-specific data, which potentially enhances their competitiveness. The selection of the appropriate technique enhanced the proper representation of the relationships between BP and LI helping business actors take advantage of the information shown in making informed decisions. Benefits derived here, such as the use of LI to determine the location and proximity of assets to hazards have been enumerated in some literature (Rostek, 2009; Adeptia, 2000; ESRI, 2012). In this second phase, the research questions like the evaluation and connecting methods, benefits added to the already existing business process for insurance were answered.

Case Study Approach

The execution of the integration was conducted using the case study approach. In the data preparation phase, a dummy dataset was generated for the test run of insurance BP. There was a setup of several runs using the insurance BP with and without LI integrated into the spatial enterprise system. The experiments done during the implementation executed the business process involved and insurance operations without the integration of LI as shown in Figure 3 above and explained in Figure 4 and also the implementation of LI embedded in the business workflow of insurance operations. There was a need for some redesigning of the insurance workflow to fit LI elements. This approach after implementation aims to enumerate the advantages and disadvantages involved in the experiments and the evaluation test of the newly created integration. The integrated insurance BP was evaluated using selected CSFs relevant to the implementation and execution of the integration (AlQashami & Mohammad, 2015; Tarhini et al., 2015). This implementation process provides answers to the research questions related to sub-objective three alongside the benefits and improvements achieved from the research method used.

1.7.2. Thesis Structure and Design

This thesis is divided into six chapters. The first chapter gives an introduction to the research topic, providing a summarized justification behind the importance of the topic while stating the current problems which the research objectives and questions pose to solve. Chapter 2 summarizes the essential literature studied and explored in relation with business processes, insurance BP, location intelligence and the integration of LI-enabled insurance BP using a spatial enterprise system alongside the strategies and requirements involved in the implementation of the integration. In Chapter 3, a detailed description of the dataset, insurance BP used and the workflow involved in the implementation carried out in Chapter 4 were provided. Chapter 5 provides the presentation of the results and discussion ensued as a result of the integration implementations. Chapter 6 ends this work with the conclusion, limitations of this study, answers to research questions and proposed recommendations for future works.

2. LITERATURE REVIEW

In this chapter, essential literature related to the works done on the automation of business processes using ERP systems and some GIS tools are summarised. The following sections give a detailed overview of literature studied and explored for the successful execution of this thesis such as the various kinds of business processes and the current use of ERP systems for the automation of these processes leading to the motivation for the need for the integration of Location Intelligence into the ERP systems used for automating the business processes and the privacy concerns raised and should be considered in the use of data information provided by individuals for data processing.

2.1. Business Process (BP)

Thakral (2011) defined business process (BP) as the sequence of organised events, carried out by people and tools which leads to the achievement of goals set by the organisation. The author highlighted the use of predictive and trend analytics of historical data as a means to fully comprehend the current state of the business process understanding and making useful inferences for the desired state of the business process. Business Process Management (BPM) is defined as the management discipline that is charged with the authority to handle business processes as assets which influences the performances of the enterprise. It also provides the company with an opportunity to optimize and scrutinise all business processes continuously, giving the organisation a competitive lead over other organisations with no BPM in place in the same sector. BPM helps accelerate and optimize the overall BP in the industry (Thakral, 2011).

There are typical BPs involved in different businesses such as marketing services, selling products, delivering services, distributing products, invoicing for services and accounting for money received. Since every core business requires these typical processes, only a few make use of systems for automating, scheduling and managing these services and processes to increase process flexibility (Rosemann, Recker, & Flender, 2008). The insurance BP is categorised as one of those few BPs that are yet to leverage the benefits of integrating an ERP system fully; creating a basis for studying the insurance BP.

2.1.1. Insurance Business Process

According to Tufvesson (2017), insurance is defined as a policy for protection against risks and unforeseen loss of life and property. This protection is signed as a means of a contract between the insurance provider, i.e. the insurer, and the insured, in this case, any client that has a policy. One of the basic principles of the insurance business is the spreading of the risk insured over a high number of policies to cover the risk incurred by just one policyholder, and which the policyholders can not cover by themselves (Tufvesson, 2017). The most common insurance BP across all kinds of the industry includes the underwriting, claims management and customer onboarding processes. These processes have a strong spatial element from the managing of addresses gotten from the customers to the assessment of risk in the underwriting processes and the logistics of handling claims by the claims management. All these processes are however, usually carried out without any consideration to the underlying spatial information. Hence, the reasons for centring on these processes for the integration of a GIS tool – Location Intelligence (LI) for the optimization and automation of the overall insurance BP.

For a successful optimization and automation of the insurance BP, the tool to be used should focus on the increase of cost-effectiveness as well as better risks management, to ensure that the insurers enhance agent and client satisfaction thereby causing an increase in market share (Thakral, 2011). Take for instance, a car insurance company; the important BPs include on-boarding of car insurance applicants, underwriting of premiums for new policyholders and claims management. Leveraging the use of LI within the ERP systems used for these processes will most definitely improve the work efficiency and increase the automation of BP by the insurance company.

2.2. Location Intelligence (LI)

Location is said to be the key to unlocking more significant insights, patterns and trends hidden within any business data and the insurance business data is not left behind (Freyd et al., 2016). Location intelligence (LI) is defined as the collection and analysis of geospatial data that is converted into useful tactical insights to solve challenges that occur within a business process. LI, as described by Seshadri et al. (2018), has the capability to identify and examine complex trends by using the geographic relationships present in information as well as leveraging geospatial technologies. From this description, it can be seen that LI has abilities suitable for both data visualization as well as acquisition utilising its positioning and geospatial properties.

Lots of insurance business data have the location element embedded in it like the postcode of the insured's home or office address. The fact that there is the presence of a significant amount of location element in the business data enables the logic and reasoning behind using LI as opposed to other rudimentary BI tools or product for getting better inferences from the business data stored or acquired. The construction of an inexpensive LI platform that has the capability to satisfy traditional vendors as well as provide the recommended benefits can be done using any Service-Oriented Architecture (SOA)-compliant mapping software from any open-sourced database management system. SOA helps to reduce the amount spent on getting the traditionally proprietary vendors like Esri (Seshadri et al., 2018).

LI allows for the improvement in business processes such as the efficiency and quality of production as well as the response time required to deliver these products and solutions (Thakral, 2011). LI is the additional geospatial tool which enables decision-makers in the organisation to gain better insights and understanding of both current and desired achievable states of the overall BP. In many industries, there exists the use of obsolete methods such as spreadsheets and reports for deriving insights from business data. The use of these methods limits the extent to which insights, trends and patterns can be extracted from business data hence the need and current use of LI for such actions in the insurance industry (Seshadri et al., 2018).

2.2.1. Location Intelligence in Insurance Industry

The main domains for which LI is suited for insurance BPs include (Seshadri et al., 2018):

- *Catastrophe Modelling and Mapping Services* – This involves the use of LI tools to map out areas or zones which are prone to natural risks such as floods, hurricanes, earthquakes, fires. These enable underwriters to make decisions and write premiums based on the locations of property or assets close or far from these areas.
- *Customer Self-Service Portals* – LI services when integrated with customer self-service portals help improves customer satisfaction. This can be achieved by extra value-added services such as the input of the customer's postal code, giving them more localised information about the store to contact or visit for products and services.
- *Claims Management* – with the utilization of LI-enabled platforms for claims processing, helps improve the time required to process and manage claims which may occur in magnitudes such as claims from residents affected by the wildfires within a known region, e.g. wildfire incident in Australia. The use of LI-enabled technology can also help the claims department forecast the number of adjusters and inspectors required to cover an incident using optimal routes. LI technologies used by carriers helps improve the optimization of routing and workloads for the claim adjustors. Cost savings is also a benefit of making use of LI tools, as it creates a platform for active checking of policyholders by the claims department to see if there is a need for blocking specific services — for example, blocking hotel rooms and car rentals in need of replacement coverage.
- *Geo-Analytics for Agents* – Agents with the help of LI platforms can make geo-targeted adverts, campaigns and eventually sales to customers in need of specific insurance policies based on the data stored or acquired.
- *Fraud Detection and Incident Tracking* – with the help of LI platforms, the claims department can detect fraudulent claims made by timely verification and investigation of such claims, which may otherwise have gone unnoticed. It can also be used to track the number of claims made within a region and to ensure this number does not exceed the predicted threshold based on the risks allocated to the region.

According to Thakral (2011), one of the numerous benefits resulting from the integration of LI with the insurance process includes the general improvement of operational efficiency and business innovation. Operational efficiency consists of enhancement in employee productivity, faster processes, increase in the rate of partner responsiveness and better management of the industry inventory. Business innovation includes the enhancement of product capabilities, increase in the production of new products that have been tailor-made for the customers and an improvement in the accuracy and quality of customer service within the industry (Thakral, 2011). Another beneficial improvement of integrating LI with insurance BP is the ability for the organisation to obtain essential insights, identify trends or patterns amongst customer and demographic information empowering a well-informed decision-making process (Seshadri et al., 2018).

Currently, some insurance companies are taking the initiative in leveraging the location element acquired from the insurance data provided by their policyholders. In the case of a car insurance company, there are some factors which the insurers consider and require from an applicant at the initial state of the policy sign up. These factors help the insurance company determine the premium payable by a car insurance policyholder. According to Allstate Insurance Company (2017) and Insurance Information Institute (2019), the primary factors are:

- *Information on the car* – type of car driven, kind of security features already built-in the vehicle like anti-lock brakes and anti-theft devices.
- *Driving habits of the applicant* – information from driving records, driving distances and how often the applicant drives are used in the premium calculation.
- *Demographic factors* – where the car is most often parked asides the home, and office address of the applicant is an example of the demographic factors considered. The age and gender of the applicant also contribute to the decision made with regards to the premium calculation as well. Studies show that younger and less experienced drivers are likely to pay more for car insurance than those who are older and have more experience in driving.
- *Coverage limit and Deductibles* – the coverage, limits and deductibles selected by the applicant also play a role in the premium determination. Depending on the insurance company selected, this varies with each type of coverage selected like liability or collision coverage, medical payments or personal injury protection. Generally, more coverage translates to potentially higher premiums.

Mobielschademelden (2020) emphasised the use of location as implemented beyond the traditional use for insurance policies but also being imbibed into the governmental parastatals enabling improved feedbacks from the citizens to both the government and for their insurance companies as well. Recently, there has been an upshoot in car incident reporting within the Netherlands as more drivers embrace the use of mobile apps developed by insurance companies for this purpose. The procedure for reporting the incident is as follows (Mobielschademelden, 2020):

- Take photos and approach witnesses – pictures of the damage and the accident situation while recording the details of witnesses during the accident.
- Start damage reporting, select vehicle and accident type – here the type of vehicles involved in the accident are noted as well as the type of accident that occurred.
- Record data – the information of the drivers is recorded, like the information provided by an applicant for a car insurance policy.

- Report damage and injury – the damaged caused to the vehicle of the policyholder is reported, and in the case of injuries, the indication of possible physical injury is reported as well.
- Describe the situation – a summary of how the accident occurred is given, with the policyholder indicating; the direction of the drive, the action of the driver and the path taken by the driver just before the accident occurred or that led to the accident occurring.
- Review the data – the information provided prior is reviewed with a procession to the next step.
- Confirm the damage report – confirmation of the damage report given is done via SMS code from the other party. This party receives the notification, including the code by SMS.
- Add extra information at home – the reporting of the damage and accident can be further edited and improved at the home of the policyholder with the inclusion of more photographs as desired.

Reporting damage via the "mobielschademelden.nl" app helps with the contribution to road safety within the Netherlands since road safety authorities receive the information provided by participants about the conditions around the accident and the location of the accident. The information provides the road safety authorities with more clarity on dangerous and traffic events which needs to be adjusted to reduce the number of reported road accidents (Hsu, Chou, & Shiu, 2016).

The required details for the report include personal information, car registration number provided by the party involved in the accident and agreed upon by the other party as well is protected from the road safety authorities and only disclosed to the insurer or lease company (in the case on of the cars is on lease). This is done to avoid the breach of the parties' privacy.

2.3. Implications of the Privacy Laws on the Usage of Personal Data by the Insurance Industry

Recently, concerns have been raised regarding the integration of location-centred techniques and use of LI into the insurance processes. One of such apprehensions is the issue regarding privacy (Christel Choo, 2018; ICO - Information Commissioner's Office, 2014), this is a delicate issue as privacy exhibits a critical concern to the implementation of LI integration into the insurance BP. The need to ensure that privacy is not breached is essential, as insurance data is mostly gathered from dealing with personal data acquired or provided by individuals. There are several privacy laws (Choi, Jeon, & Kim, 2019; Kounoudes & Kapitsaki, 2020; Pantlin, Wiseman, & Everett, 2018; Tikkinen-Piri, Rohunen, & Markkula, 2018; Troncoso, Danezis, Kosta, Balasch, & Preneel, 2011) in the world that help to ensure the protection of individual and group privacy, by reducing the risk involved or undertaken during privacy breach and neglection or overlooking of privacy rights by companies, third-party businesses and individuals themselves. There are significant privacy issues embedded in the collection, pre-processing, and post-processing of data. The workflow currently used for the integration of the LI into the insurance BP is executed successfully regardless of the different kinds of privacy laws enforced or created in a legislative region, such as the GDPR. There are several approaches used in mitigating or reducing the risk of location privacy and data breaches. Location privacy has various definitions depending on the aspect of location information involved. Duckham and Kulik (2006) defined location privacy as "a special type of information privacy which concerns the claim of individuals to determine for themselves when, how, and to what extent location information about them is communicated to others".

Geoprivacy – the control of location information – is an important challenge in privacy; the lack of which leads to geoinformation disclosure (Keßler & McKenzie, 2018). The methods developed to reduce the risk involved in geoinformation disclosure are categorized as Location Protection Methodologies. These are protective strategies taken either by individuals or companies to reduce privacy breach a third party. There are various types and methodologies for location protection; these include (Kalnis, Ghinita, Mouratidis, & Papadias, 2007; Kounadi & Leitner, 2016):

- *Geographical Masks:* they involve either the random displacement or adaptative placement of location information to avoid a re-identification of location information by a third party, intruders or hackers. This includes strategies like random perturbation, adaptive aerial elimination – adaptative masking.
- *Cloaking:* this is an adaptive method of location protection. It is a method that only discloses the location area and not the original point or location. The cloaking method is like the geographical iso-mask method. The only difference is that the cloaking method reduces the resolution of the data but does not introduce errors; it only gives the original location a blurry effect.
- *Pseudonyms:* this involves the alteration of original information using keys, quasi-identifiers and sensitive attributes. It disassociates key attributes from the other attributes to limit identity disclosures.
- *Obfuscation and Negotiation*: this involves the deliberate degrading of the quality of the information provided by an individual about his or her location in order to protect his or her privacy. Negotiation occurs when the individual liaises with the data collection company on the kind of data collected and to what extent the data can be used during analysis.

The use of these strategies together with the privacy laws passed by the government such as the General Data Protection Regulation (GDPR) passed by the EU government lessens the risk of spatial re-identification (Curtis, Mills, & Leitner, 2006). This regulation is related to the protection and harmonisation of personal data across the EU and was passed in May 2018. The goal of introducing the GDPR is to improve user involvement in privacy protection while strengthening their rights with new requirements in data handling by companies that handle personal data information. The policyholders, in the case of insurance companies, need to be aware of the risks involved in the collection of the private data they provide during the application or claims requests processes. They also need to be in the loop when a processing strategy for deriving insights from their data is developed. To make use of the data collected from the data subjects, the companies can develop processing strategies that use anonymisation techniques and draw inferences via probabilities (i.e. randomisation). Since the GDPR focuses on problems associated with data collection, these problems are classified into the purpose for the data collected, the quantity of data collected and the duration for which the data can be stored (Kounoudes & Kapitsaki, 2020).

The need for compliance with the new privacy legislation on the collection of personal data and extraction of data subject's information by data collection companies (like insurance companies) reduces or eliminates the risks involved in the breach of privacy. When GDPR is not adequately implemented sanction results, just like with other infringement of legislation in society. To avoid such sanctions, companies must comply with all the rules and regulation under the GDPR when dealing with data (Tikkinen-Piri et al., 2018).

According to Tikkinen-Piri et al. (2018), with the enforcement of this law, all companies within the European Union (EU) and across the globe that make use of personal data and the observation of data subjects' behaviour have to be governed by GDPR. The use of personalised data and data extracting technologies comes with various benefits for both the companies and the consumers of their products but stands to be privacy risks if the data is not well managed and the database of the companies are hacked into.

The need for companies to comply with the mandatory requirements of the GDPR involving the data collection ensures that the data processing strategy used for processing personal data and information from data subjects meets with the mandatory requirements as declared by the GDPR (Pantlin et al., 2018). Compliance with the general provisions and principles of the GDPR by the companies should be done in such a way that the data processing should be made transparent as well as the involving of pseudonymisation of the customer names or identity to reduce the recreation or re-engineering of the information by non-authorised or a non-compliant third-party. This is defined under the principle of the companies getting involved in the processing of data which limits or does not involve the use of individual identification (Tikkinen-Piri et al., 2018).

In the case that the data processing is outsourced to other companies, the company must also sign an agreement that the used techniques adequately comply with the GDPR. Consent of individuals should be sought before the prior use of the information provided by them. This ensures that the individuals are fully aware of the way the information provided will be or can be used (Pantlin et al., 2018).

In the attempt to comply with the GDPR, data collection companies have created contracts that provide the data subject sufficient information about the techniques used for the data processing as well as "opt-in" choices for apps developed to help the customer make requests to the company. Transparency and readability of these privacy contracts to be signed off by the data subjects are expected to improve as this strengthens the compliance of the companies as well as the trust of the customers in the companies (Choi et al., 2019). Transparency and modalities involve the communication of the personal data processing methods in place for the extension of the modalities to the individuals' whose information is required or submitted. The data subject must be fully aware of all the intended interests of the companies as regards the personal data before signing any contract or usage of any application.

Information and access to personal data are to be provided to the data subject as one of the regulations of the GDPR. The data subject has a right to the information processed by the first company based on the data obtained from the data subject. There is also a need for the data subject to be informed before any information is outsourced or shared with a third party for any data processing or any other use. The data subject has the right also to demand rectification of the data processing or erasure of personal data used in the case of the potential bridge of privacy rights or high level of privacy risks (Tikkinen-Piri et al., 2018). In the case where the data subject disallows, "opts-out" or does not give consent to providing such personal information or the use of the information provided, the data companies should not discriminate or treat that particular customer any different from the rest. There should be equality in the treatment of all customers, no matter the decision taken by the data subject as regards the processing of the data given (Choi et al., 2019).

2.4. Integration of LI-Enabled Insurance BP With an ERP System

ERP has been seen as a mechanism that helps to standardise and integrate BP to accelerate accessibility to common resources across the company. In order words, ERP systems aid organisations by the improvement of operational efficiency and by the distribution of information throughout the organisations (Shen, Chen, & Wang, 2016). According to these authors, the use of ERP is often a necessity in the planning of resources in the organisation. The benefits of ERP systems can be categorised into two (the tangible and intangible benefits). The increase in productivity, improvements in operations and customer satisfaction are all examples of tangible benefits of the ERP system. Examples such as better integration between systems, improved business performance and communications within the organisation can be classified as intangible benefits of ERP system. In literature (Shen et al., 2016; Motwani, Subramanian, & Gopalakrishna, 2005; Yen & Sheu, 2004), the case study approach has been selected as an examiner for the implementation of ERP systems. From the use of single to multiple case studies, researchers have been able to come up with some critical factors that are relevant in the evaluation of ERP system performance. The methods used to evaluate ERP systems vary from empirical surveys (AlQashami & Mohammad, 2015) to case studies (Shen et al., 2016).

For this research project, the evaluation of an ERP system was assessed by the implementation of a case study. The ERP system used for this work is the ERPNext which was selected on the basis of its ability to implement ERP benefits for insurance BP. The ERPNext is built on the Frappe technology framework, which makes this a creative and dynamic environment for developing an individual application that can be integrated into the ERPNext for resource and process management by individuals or companies. The foundation of the Frappe framework consists of Python at its core with MariaDB as DBMS, and the use of HTML, CSS and JS for its web applications. The dynamic nature of the ERPNext is because it integrates well with other applications using the Frappe Representational State Transfer API (i.e. Frappe REST API). This is a user-friendly web service (Chen, Ji, Fan, & Zhan, 2017).

2.5. Requirements and Strategies Involved in the Integration of LI With Insurance BP

There are specific requirements and strategies which form the basis for post-evaluation of the ERP system implemented. With the utilization of these requirements in the methodology process, results obtained can be adequately analysed. According to Shen et al. (2016) some of the evaluation criteria should be;

- *Completeness*: this involves covering the crucial aspects of the decision-making process, decisions such as the premium payable by each policyholder, the strategy used for premium estimation and calculation and the development of promotional discount services for policyholders with fewer claim requests within the policy year.
- *Operationalization*: requires that the criteria chosen are meaningful for the decision-making analysis as well as the process.
- *Decomposability:* the criteria can be divided into simpler components of the evaluation process.
- *Non-redundancy*: this involves the elimination of redundant criteria, i.e. factors which measure similar things (double-counting criteria).
- *Size:* the total number of criteria for adequate feasibility should be the bare minimum.

Strategies have been put in place for the implementation and evaluation of ERP systems used for the integration of LI for insurance BP. One of these methods is the "costs savings per transaction" method. Whichever strategy is selected for the integration of LI in the insurance BP, it must have the ability to support insurance transactions in a streamlined, flexible and agile manner, as this will help insurers to perform interoperability services on the systems used (Thakral, 2011).

Another method of measuring the performance level of ERP systems involves the use of the hierarchical balanced scorecard (HBSC) model, which is a solution for handling the complexity of the implementation of the ERP system. This model utilizes multiple criteria for decision making, and it is a systematic approach to bridge the gap between ERP performance measurement and vital performance measurements in the organisation (Shen et al., 2016). Four perspectives applied in evaluating the implemented integration:

- Financial perspective
- Customer perspective
- Innovation and learning
- Internal business process (IBP)

Figure 5 shows the specifications involved in each aspect and the classified examples.

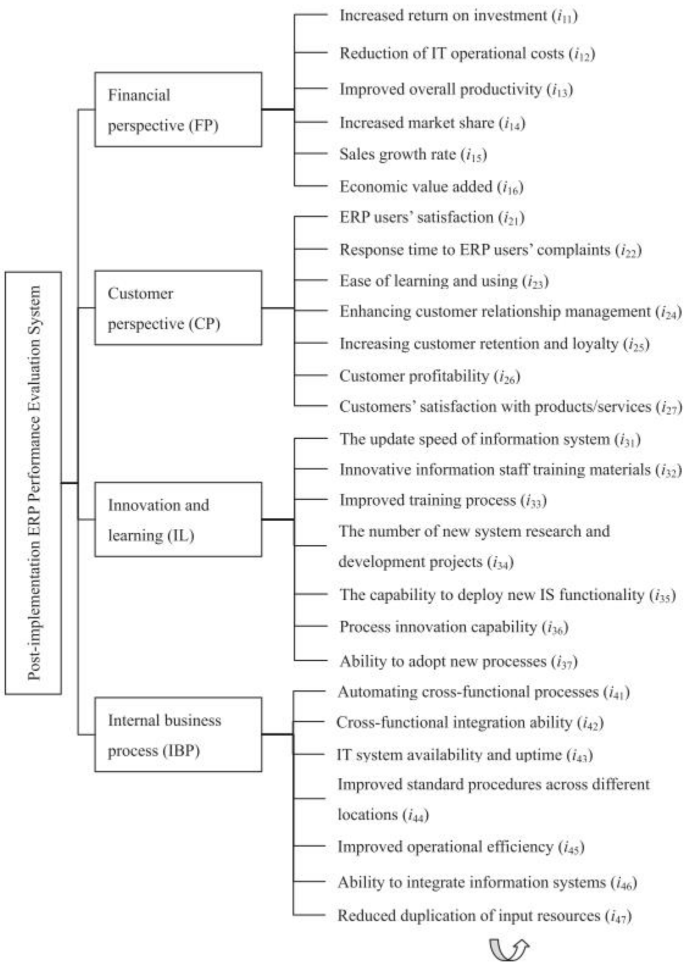

Figure 5: HBSC Performance Measurement System for Post-Implementation Source: Shen et al. (2016)

3. METHODS

This chapter describes the methodology involved in the integration of spatial enterprise planning system using LI into an insurance company's business process for more automated and optimized BP. It explains how existing insurance BPs such as premium estimation and claims management were extended and changed to integrate LI. With considerations of the requirements such as the elimination of redundant information in the system developed, for post-evaluation as stated in section 2.5, the steps carried out under the methodology and implementation, allows for adequate evaluation of the method used for implementing the integration.

The primary tasks of the insurance BPs discussed in this research work are limited to functions involved in the automation of insurance workflows for the car insurance case study. The existing data properties required for purchasing a car insurance policy include data obtained from the onboarding process for an applicant (i.e. the car owner):

- name
- postcode and address
- age
- the car to be insured
- income level

There are, however, some extended approaches required for the incorporation of LI into these properties. Hence, the reason to include checks to help enhance the calculation and determination of an applicant's eligibility for the policy, these checks are:

Application completeness – an application must include all the information listed above as a minimum criterion with specifics on the kind of assets to be insured, like for a car insurance – car plate number, driver's licence, type of car.

Insurance Eligibility – factors such as gender, age, marital status, geographic location, driving record, the kind of car driven and credit score of the applicant are considered (Hsu et al., 2016). For the duration of the check for an applicant's eligibility, there is a need for risk analysis to be done by the company. This analysis is done per applicant based on movements from their home location to other locations such as grocery stores and work, as some locations tend to be riskier than others, for instance, the risk level in the city centre or urbanized area is relatively higher than that of a remote or rural area (Felsenstein, Vernik, & Israeli, 2018).

Case suitability – this involves the assessment done on the applicant's insurance case. The complete application information of the applicant is assessed by performing a background check on the applicant to determine if the risk level of the applicant can be covered. For instance, the risk level for a car policy application is determined by assessing the driving behaviour, years of driving experience and the type of car driven by the applicant (Hsu et al., 2016).

Premium Calculation – This involves the estimation of the premium to be paid by the potential customer (i.e. the applicant). For the best possible calculation of the premium, the information obtained from the checks done on the application such as how; complete the form is, eligibility and the case suitability of the applicant is input into the calculation. These inputs are also added to the flat-rate premium ratio for the policy type.

The tasks chosen are regarded to have spatial elements in them such as the address of the customer, postal code, location of the cars (i.e. where the cars are mostly parked, route the cars take often) and the home address of the customer. This section describes in detail the specific ways of approaching the problem, and the methods used for achieving the aim of this research and forms processes for answering the research questions.

3.1. Dataset Description

The data used in this research is a synthesised dataset which mimics what an original insurance data looks like. Figure 6 shows the entity relationship diagram of the dataset. The insurance data consists of the following information;

- **Applicant information:** an applicant is someone who submits an application to obtain a car insurance policy. The applicant dataset contains information provided by the applicant during the onboarding phase for car insurance. Included are attributes like the applicant's name, postcode and address, age, income level, the asset to be insured (i.e. car information – the type of car, licence plate number), and driver's licence.
- **Customer information for claims requests:** a customer is a current policyholder. The customer dataset consists of the following attributes: the name of the customer, the amount insured by the customer, the premium paid, policy details (ID, date, type and renewal date) and address of the customer with the postcode included. The location of the customer is derived from the home address by geocoding the postcode given by the customer.
- **Claims information:** Claim data should mostly contain what incident occurred, the date of occurrence as well as the location of the event. For example, the data acquired from a customer's car claims request should contain customer details, and car details as this help to track the route travelled as well as all the locations where the car must have been parked. The significant attributes in the claims dataset used include: Policy ID of the customer, beneficiary, claim event, amount claimed and also the location as derived from the customer information provided. The claim event may be one of several types: accident, theft, flood, property loss and fire which occur during the customer's policy validity. For the purpose of this study, the claim event type includes only theft, accident and fire. These events are harmonized based on data limitation but can otherwise be subdivided into :

  - o Fire incident which occurs per car or zone (i.e. the total number of fire incident within each zone over a period of time).
  - o Accident occurring as a result of person – person or person – amenities (like traffic poles or road curbs).
  - o Theft which may take place per car or per zone

- **Insurance Zones**: these are the zones covered by the company. These zones are selected on the basis of addresses of the policyholders. For any zone, we have its name, the number of events recorded over a specific period within the zone (fire, accident and theft) as well as its geographic region. The information provided in these attributes can be used to improve the decision making of the premium calculation. For the execution of this project, the dataset had a spatial extent at the neighbourhood level for Enschede as a case study, as illustrated in Figure 7. The neighbourhoods were characterized with attributes such as the road networks and the number of buildings associated with each zone. The roads and buildings were used to develop the accessibility and urbanization level for the whole spatial extent – Enschede municipality and hence determined the level of built-up areas and more congested zones based on the population of Enschede. The zones had further population information such as the ratio of men to women and the percentage of drivable age with classes such as 25–44, 45–64 and 65 years. In these zones, the requirements and strategies are put in place to help make decisions by the insurance and claims manager during the on-boarding and managing of claims made by a customer. The need to take into account the privacy of the address of customers are also put in place here to elude re-engineering of customer locations by unauthorised parties.

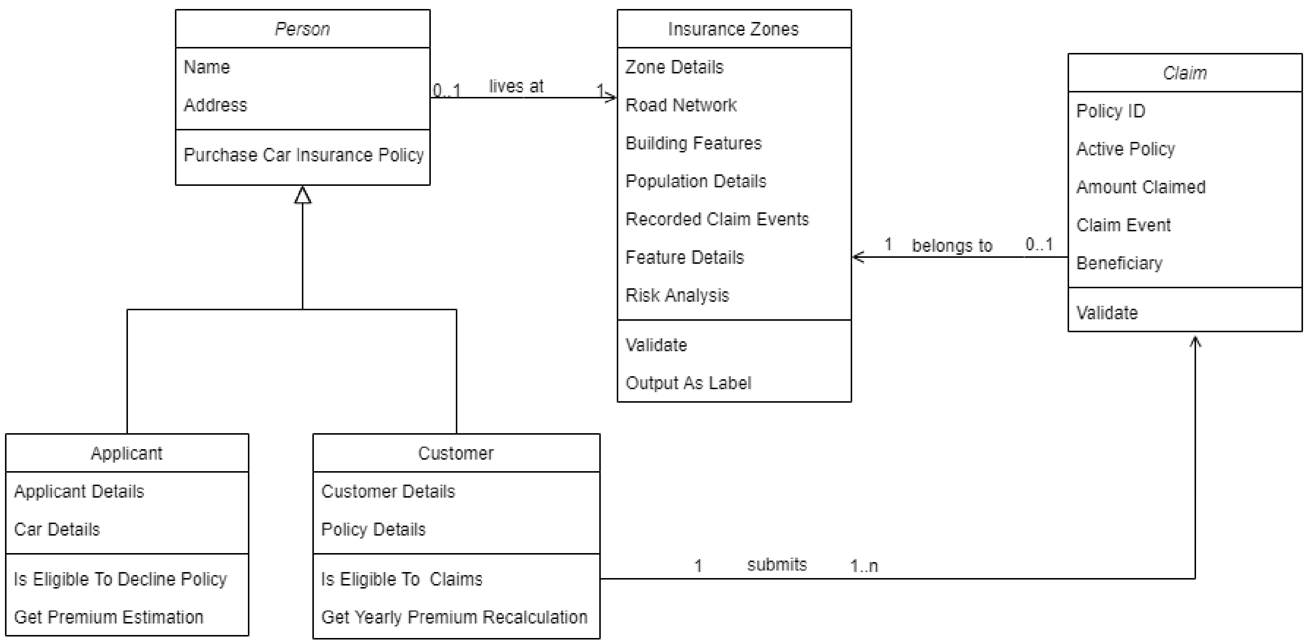

Figure 6: Class Diagram Showing the Entity Relationship of the Insurance Dataset

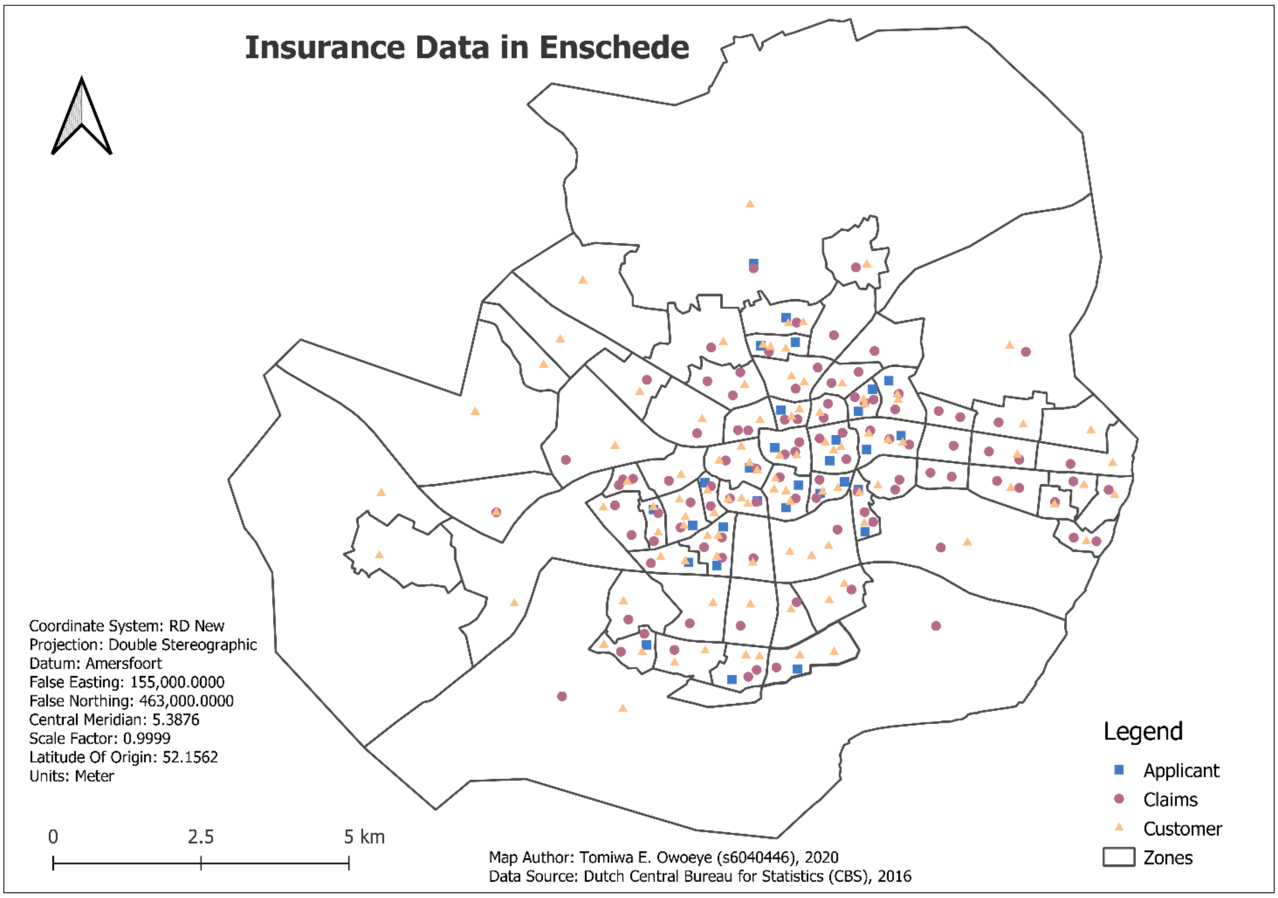

Figure 7: Map Showing the Distribution of the Insurance Data Within the Case Study Area - Enschede

3.2. Supplementary Data Inputs for the Integration of LI Into the Insurance BP

The integration of LI into the insurance BP necessitated the generation of the supplementary dataset, which are not common in existing insurance data input to enhance the analysis carried out during insurance BP. These data inputs are overlaid with the insurance datasets used for the implementation process of the integration of LI into a car insurance business process using the spatial enterprise planning system ERPNext. Figure 8 illustrates the entity relationship of the additional data inputs. The following sub-sections outline these data inputs:

i. **Stadsdelen:** this is the code for the city districts that each insurance zone belongs to, they are the Noord, West, Oost, Zuid and Centrum Stadsdelen. This input contains attributes like the area of buildings within each stadsdeel (getting sums from the building areas based on the building categories – commercial, industrial and residential); length of roads within each stadsdeel (sum from major roads).

ii. **Zones:** this consists of attributes like postcode, name and code of the neighbourhood; area of buildings within each zone (as sums from the building areas based on the categories – commercial, industrial and residential); length of roads within each zone (sum from major roads).

These zones also contain information about the insurance zones defined in section 3.1, which include the total population of the inhabitants, the percentage of drivable age inhabitants and the number of claim incidents per zone.

iii. **Buildings:** these structural features are contained within the spatial extent of the case study area – the boundary of Enschede. They are assigned a stadsdeel code as well as the neighbourhood code to associate with the zone and stadsdeel to which the buildings belong. The area for both the stadsdeel and zone were calculated in meters for all the buildings. The building features are classified into three categories: commercial, industrial and residential, these classifications are used for data processing for developing the built-up areas within the zones.

iv. **Roads:** these contain all the road networks within the boundary of Enschede, it is also assigned a stadsdeel code as well as the neighbourhood code to get the zone to which the roads belong. The length for both the stadsdeel and zone were calculated in meters for all the roads.

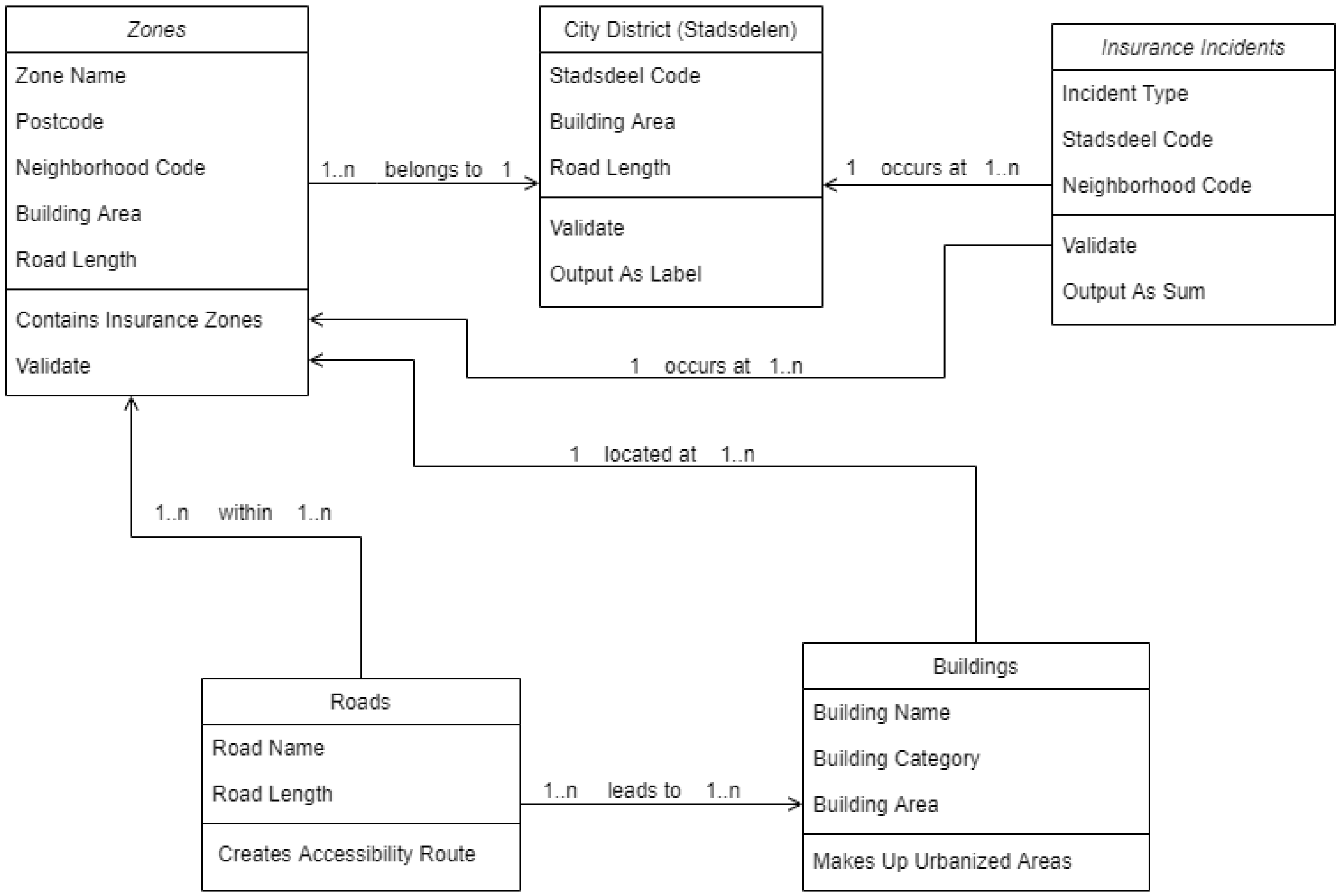

Figure 8: Class Diagram Showing the Supplementary Dataset for Insurance Workflow

v. **Insurance incidents:** these are the incidents which lead to claim requests. For the implementation process, the numbers used were generated using the NumPy module for generating randomised numbers and setting the seed to 0, this enables the generation of the same numbers for every re-run (i.e. helps for recreating this process during verification and testing).

```
import numpy as np

# setting the seed
np.random.seed(0)

# initializing random numbers for theft occurrences setting min value = 0 and max value =
90 for the 70 zones
Theft = np.random.randint(low = 0, high = 90, size = 70)
print(Theft)

# initializing random numbers for accident occurrences setting min value = 0 and max value
= 100 for the 70 zones
Accident = np.random.randint(low = 0, high = 100, size = 70)
print(Accident)

# initializing random numbers for fire occurrences setting min value = 0 and max value =
50 for the 70 zones
Fire = np.random.randint(low = 0, high = 50, size = 70)
print(Fire)
```

3.3. Process Definition for Automated Insurance Process (AIP)

The essential tasks in the onboarding of a customer and claims AIP are those that require an action plan, specific inputs, expected outputs and data model to run the action successfully. These tasks and their respective lanes, as illustrated in Figure 9 and Figure 10 are listed as follows:

- Insurance Manager Lane (Risk assessment)
- Underwriter's Lane (Insurance eligibility, Premium calculation)
- Insurance Advisor Lane (Application completeness)
- Applicant Lane (Application requests)
- Customer Lane (Claims requests)
- Customer Care Lane (Notification process)
- Policy Lane (Policy determination)
- Claims Lane (Claim requests validation and assessment)
- Finance Lane (Claims settlement)

Table 1 shows the tasks involved in acquiring a car insurance policy and processing a claim. Both inputs and outputs were normalised to handle the extreme range of cases for claims, making data analysis overly complicated. For example, to account for variations in population, the number of claims is normalised using population density.

The person-in-charge depicts the performers of the tasks, so the use of the term department does not refer to specific departments in the organisation, but more like roles put in place for the execution of the individual tasks.

The insurance data must be curated before it can be ingested by the database to improve its structure. The insurance claim data is essential data which not only helps the insurance company if well managed, but that can be leveraged for other purposes by the governmental body or relief organisations in post-disaster response, e.g. determining the extent of the disaster caused by claim events such as fire, theft or accidents within an area (Zischg, Mosimann, Bernet, & Röthlisberger, 2018). Claims are crucial to look into as a valid claim must provide details on the "who", "what", "when" and "where". The reason to study the claim process is that it can leverage location obtained from the "when" and "where" details. Leveraging the information provided helps the insurance company determine the authenticity of the claim requests, thereby improving claims management process, as illustrated in Figure 10 and described in section 3.3.2.

Table 1: Individual Tasks Description

Individual Task	**Input**	**Expected output**	**Person In-charge**
Application Requests	Application form	Notification on insurance policy created/rejected	Applicant
Application Completeness	Filled application form	Notification on application completeness based on customer information provided	Insurance Advisor Lane
Insurance Eligibility	Complete application form.	Notification on eligibility status based on eligibility factors	Underwriter Lane
Risk Assessment	Applicant details (age, postcode, gender, driving record)	Notification of approval of insurance applied for	Insurance Manager Lane
Premium Calculation	Eligible application forms, premium ratio, approved cases after a risk assessment	Annual premium estimation, premium underwriting and policy created	Underwriter Lane
Claim Requests	Claims form	Claims reimbursed/declined	Client
Notification Process	Policy status update, policy coverage update, claim request update, reimbursement	Notification alerts - policy status, policy coverage, claim request, reimbursement	Customer Care Lane

	transaction report	transaction	
Policy Status	Client policy details (e.g. client policy ID, policy type, start and end date of the policy)	Client policy status; policy activity, and coverage.	Policy Lane
Validation of claims request	Filled claim form	Decision made based on, claim validity, policy status and coverage and reimbursement report	Claims Lane
Claims Assessment	Valid claims request - active policy status and coverage	Approved Claims	Claims Lane
Claims Settlement	Approved claims	Claims Reimbursement	Finance Lane

3.3.1. Framework for the Integration of LI Into Onboarding Customer for Insurance Process Workflow

During the onboarding of a customer for a car insurance policy, the following processes are executed to leverage the spatial elements provided by the applicant fully. Figure 9 provides the framework that summarises the critical processes carried out for this.

The applicant initiates the application process by filling and submitting the form online via the platform of the insurer; the insurance advisor unit receives the digital form.

The next lane is the insurance advisor lane which processes the information submitted by the applicant and which is in charge of communicating the decision to the applicant. The following processes are carried out in this lane:

- The digital application form is received and checked for completeness using the application completeness criteria.
- If the application is found incomplete, a request is sent to the applicant to provide more information.
- On completion, the application is forwarded to the underwriting unit.

The underwriting unit carries out the following processes:

- Assessment of the eligibility for insurance, based on criteria defined by the company.
- If the application is ineligible, the insurance advisor unit is notified, and the insurance advisor in-charge sends out a letter of rejection.
- An eligible application is used to calculate the annual premium payable by the applicant and is sent to the insurance manager for scrutiny on risk assessment.

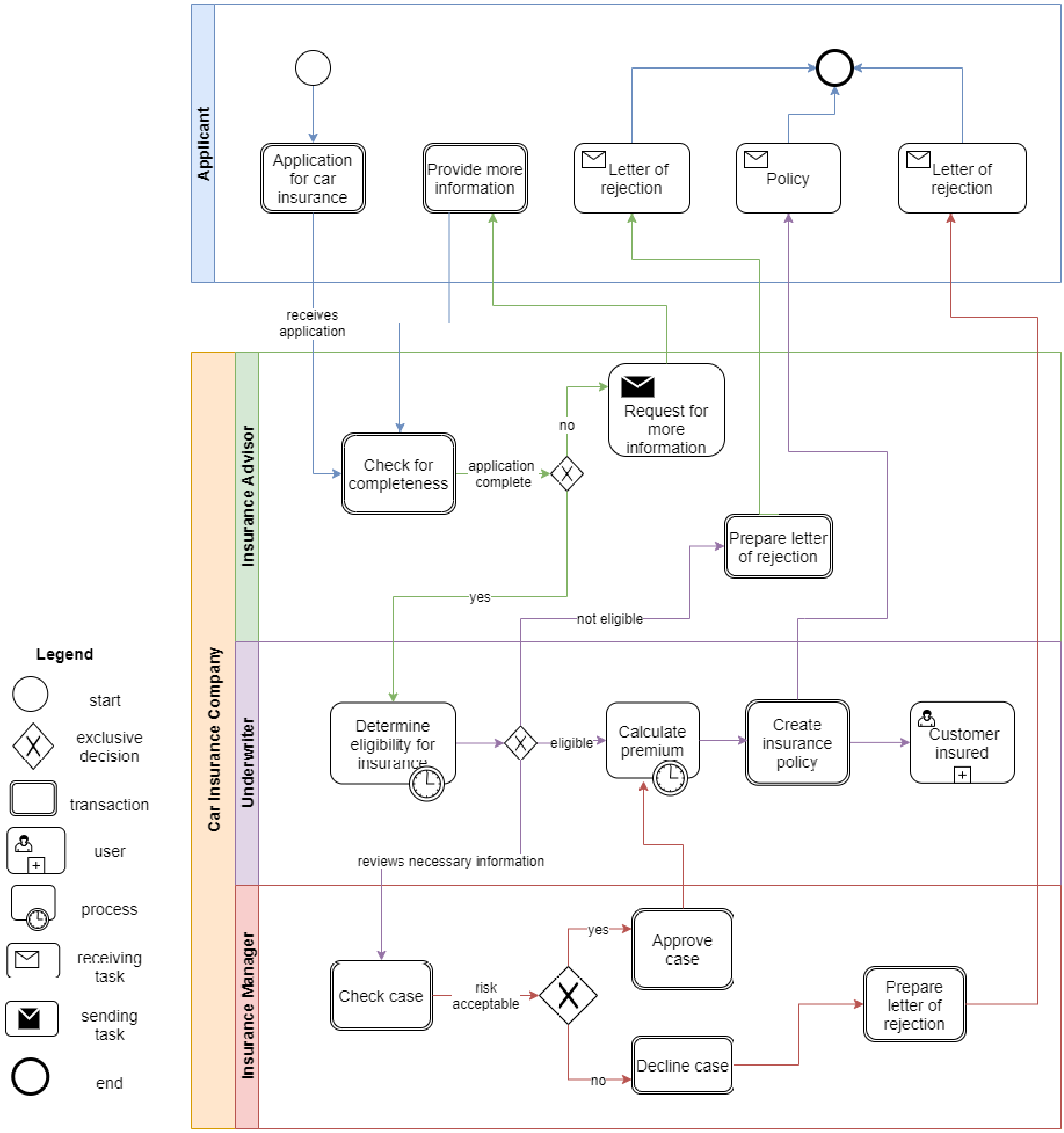

Figure 9: Automated Insurance Process for Onboarding a Customer for Car Insurance Policy

In the insurance manager lane, risk assessment is carried out, and the following processes take place:

- The complete and eligible application is sent in to assess insurance policy go-ahead considering all risks. Risk options include the applicant's area of stay, car value, applicant's record on driving behaviour, applicant's years of experience.
- The uninsurable case is disapproved, and this decision is passed to the insurance advisor unit from where the applicant is sent a letter of rejection, as demonstrated in Figure 9.

- The insurable (thus, approved) case, is transferred to the underwriter as another input for premium calculation.

The underwriting unit calculates the premium. The underwriters receive the information obtained from both the eligibility and risk assessment processes as inputs, to estimate the premiums payable by the applicant.

3.3.2. Framework for the Integration of LI Into Insurance Claims Process Workflow

The processes are timed and assigned to designated personnel, depending on the kind of task (Figure 10). The looped processes, which are repeated procedures within the claims workflow, are used during a request to the database as they exchange data with the database.

The workflow starts with the Customer Lane, as shown in Figure 10. Here the following processes are carried out:

- The request is made via a digital channel, which replaces a paper-based process, thereby optimizing the initiation of the claims requests process.
- The request is forwarded to the customer care unit.

The next lane is the Customer Care Department Lane; here, the staff executes several processes upon receipt of the request.

- The claims request is received and validated. When the validation check comes back as invalid, a notification is sent to the customer as a declined operation via the customer care department. The customer can then ask for the reasons and/or provide more details of the claims made.
- When the validation comes back as positive, the request is forwarded to the claims department.
- The request is sent to the policy department to check whether the customer has an active policy. On a negative response, the customer care department is sent an alert which in turn notifies the customer of the policy status and depending on the response from the customer there might be a decline of the request made.

The Claims Department, request directly from the Customer Care Department, after receiving the claims request;

- Once the policy status is verified active, the department further assesses the status quo of premium payments by the customer.
- Once the policy status is verified as covering the risk, the claim request is finally accepted and sent to the Finance Department for reimbursement of the claim.

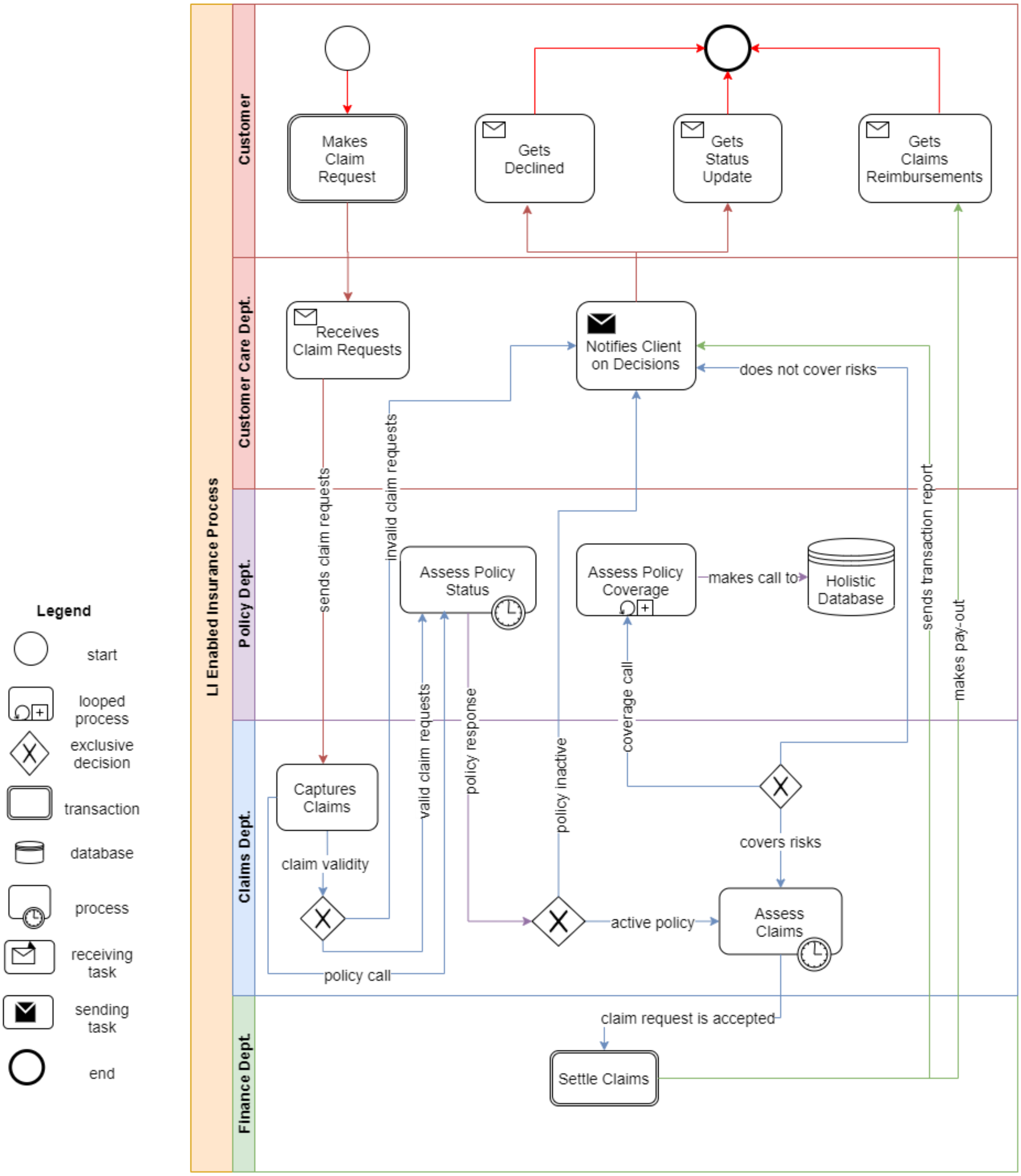

Figure 10: Automated Insurance Process for Claims Management

In the Policy Department, which occupies the third lane, the verification and assessment of the customer's policy are done as requested by the Claims Department. During the assessment of the customer's claim request, risk analysis is carried out to investigate the genuineness and validate the claim submitted. Figure 11 shows the flowchart of the spatial analysis used for the assessment of claims within the automated process for claims management in Figure 10.

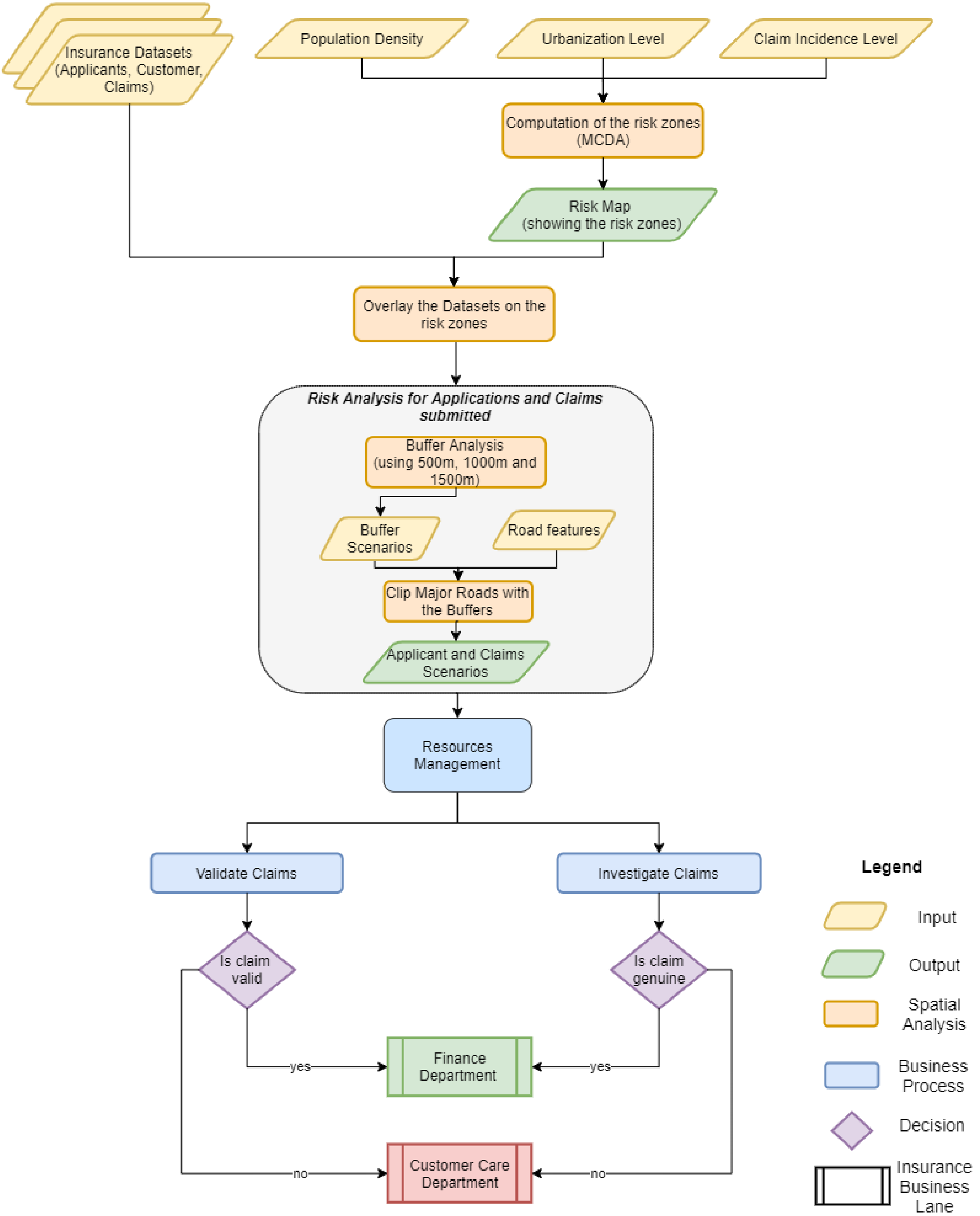

Figure 11: Claims Assessment Flowchart

The assessment and management of claims can be effectively carried out just as highlighted in the flowchart of Figure 11. The integration between insurance BP and LI generates several benefits to the insurance organization, such as:

- Better management of insurance resources with the integration of LI into the insurance BP deployed on the ERP system. For instance, insurance resources used for the logistics of claim handling.
- The holistic overview of all active and inactive policies by the insurance managers, thus developing scheduling reminders and alerts sent to policyholders for policy renewals when due.
- More efficient claims management, as it becomes easy to spot fraudulent claims as well as misconducted activities regarding claims by the customers (Wang & Xu, 2018).
- An effectively automated and optimised level of insurance resources management through location analytics, data visualization and enrichment, thereby reducing the errors or inaccuracy which may otherwise occur during the insurance BP.
- The enhancement in the execution of insurance BP from resource allocation to the management of claims, using the information of all policyholders stored in the integrated system. Consequently, creating an improved and efficient insurance BP workflow.

For the actualization of this integration analysis, additional parameters are introduced and used alongside the rudimentary insurance datasets.

3.4. Parameters for Integrating LI Into the Insurance BP in the ERPNext System

The parameters used for the integration of LI with the insurance datasets within the insurance application created on ERPNext are the following:

i. Urbanization Level

The urbanization level is the total area covered by the buildings within each zone derived in m^2. This data was generated using the ratio of "building area" to "zonal area" (from the building and zone feature respectively) per zone. It is used to determine the level of built-up areas within each zone, has urbanization mostly occurs to a more significant percentage in built-up and city areas (Parnell & Walawege, 2011; Seto, Parnell, & Elmqvist, 2013). The building features used to develop the built-up areas are: housing unit, living space, office, power pylon, garage, bicycle shed, the full list of features and attributes can be found in the Appendix section under Annexe B. The areas are calculated based on the features footprints, i.e. the building and zone footprints.

$$\text{Urbanization level: } \frac{\text{total built-up area per zone}}{\text{zonal area}}$$

The building density comprises of the contributory ratio of commercial, industrial and residential buildings per zones. The activity level that takes place within these selected building types is higher than others, hence the use of these building categories for deriving the building density and eventually the urbanization level (i.e. the built-up areas). Figure 12 shows the urbanization distribution within Enschede based on the urbanization level processed. The urbanization distribution ranges from low to high, Table 2 gives the description of these class categories derived using the "natural breaks (Jenks)" classification method.

Table 2: Urbanization Classification in Enschede

Class Label	Class Range (m^2)
Low	0.00865 – 0.00970
Medium	0.00971 – 0.20955
High	0.20956 – 0.43024

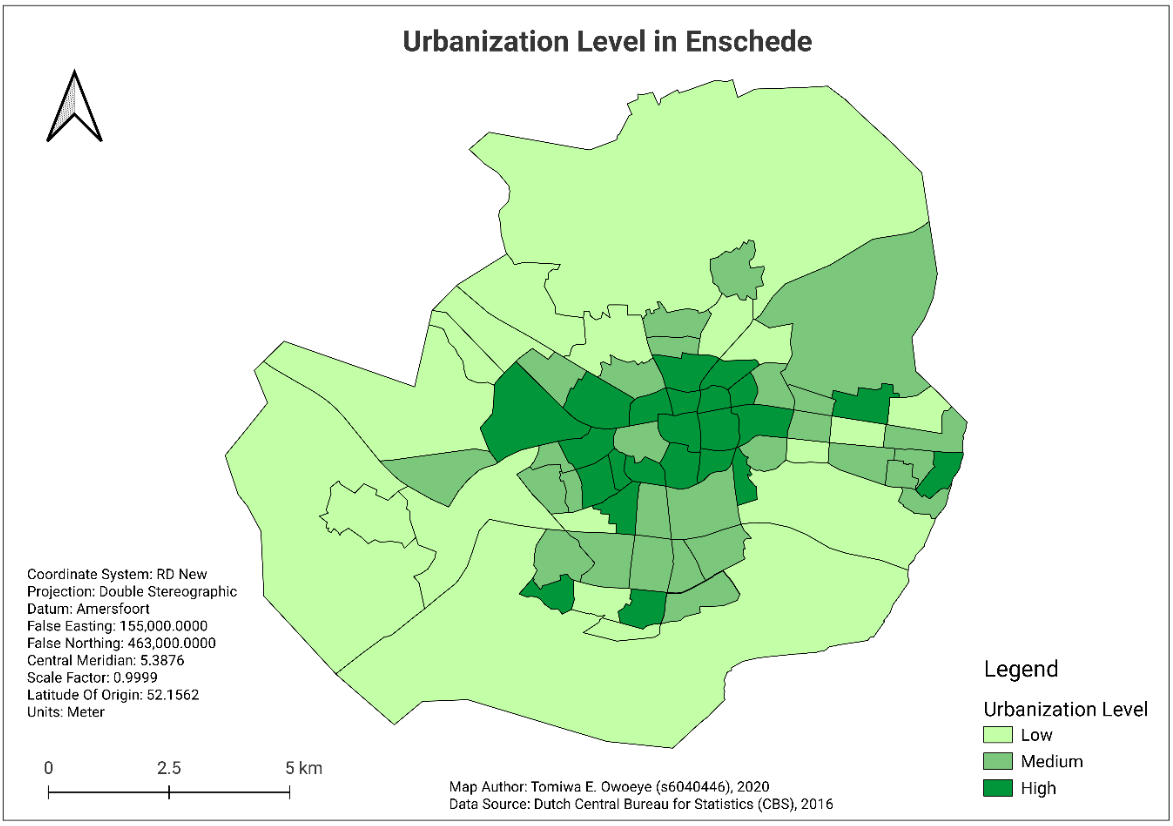

Figure 12: Map Showing the Urbanization Level in Enschede

ii. Claim Incidence Level

The Claim incidence is defined as the total occurrence of claims events, i.e. the sum of all theft, accidents or fire incidents which occurs within each zone accumulated during the policy year. Generally, the number of claims submitted for incidents such as theft, accidents or fire are aggregated per zone to determine the claim incidence level for each zone. The claim occurrence per zone is contributory ratios of all the claim events that occur within a year. The claim incidence level for each zone was computed using the zonal area derived in claims per m^2.

$$\text{Claim Incidence Level: } \frac{\text{total claim occurrence per zone}}{\text{Zonal area}}$$

The normalisation aided the reduction of the numeric columns to a standard scale without distorting the differences in the range of each value; since the claim incidence values all have different ranges per zone this resulted to the need to normalise the data (Swetha Lakshmanan, 2019; Wikipedia - The Free Encyclopedia, 2020). In Figure 13, the claim densities are visualized based on the claim incident processed. Analysing the number of claim per policy is crucial, as the number of claims influences the increase of the policy premium payable by the customer. Table 3 describes the categorization of the class labels used for the claim incidence level in Enschede. In the case of little or no claims made by a customer within the policy year, a Bonus-Malus System (BMS) can be adopted which ensures the issuing of secondary discount to the customers to improve customer experience and boost the competitiveness of the insurance company.

Table 3: Claim Incidence Classification in Enschede

Class Label	Class Range (claims per m^2)
Low	0.00001 – 0.00017
Medium	0.00018 – 0.00035
High	0.00036 – 0.00053

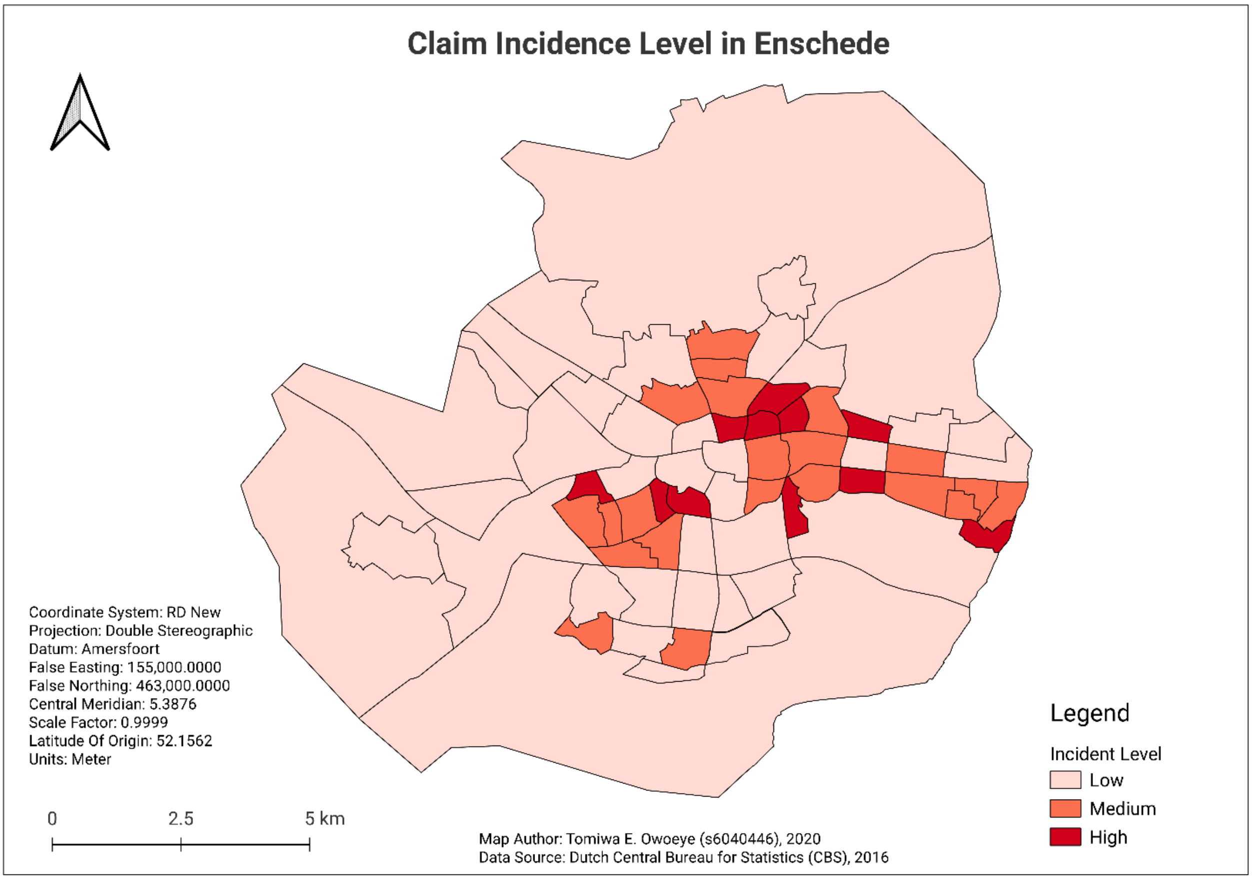

Figure 13: Map Showing the Claim Incidence Densities in Enschede

iii. Risk Zones

The risk zones were delineated based on the population density, urbanization level and claim incidence density within the insurance zones. A risk map was developed using multicriteria decision analysis (MCDA) method to classify the risk zones from " very low to very high" risk level. The MCDA is an approach used in the definition of classes or categories with multiple criteria which are part of the decision process. It is typically referred to as the best decision analysis classification method as it helps in analysing business problems that have more than one solution, e.g. risk assessment; this makes MCDA a suitable approach for classifying the rate of risks within the insurances zones (Ryan & Nimick, 2019).

The MCDA has been used for making decisions about the reduction of risks and the generation of organizational profits. It is a method suitable for classifying conflicting criteria such as the customer fulfilment versus the cost of offering this service by the insurance company, in the case of the customer, the benefits of acquiring an efficient insurance policy coverage and the cost paid for this policy (Figueira, Greco, & Ehrgott, 2005). Using the MCDA, the following steps describe the delineation of the risk zones:

a. **Define Objective:** this was the problem solved by the classification, which served as the objective of the classification. The objective is to define the risk level within the insurance zones by developing a risk map for the zones.
b. **Define Criteria and constraints**: these were the criteria selected for the successful execution of the objective. The risk zones were delineated based on the combination of critical criteria, which are the population density, urbanization level and claim incidence density within the insurance zones. Other optional criteria may be added based on the database of the insurance organization, but these three criteria are mandatory for the classification of the risk zones.
c. **Transform the values (measure for success):** the values in the criteria selected were transformed by reclassifying them to a relative scale which serves as the measure of the range of the values between the criteria, e.g. the ranking of one of the criteria "population density" from low – high therefore creating three classes for the criterion, the ranks were then assigned the transformed numeric values – 1 for High class; 2 for Medium class; 3 for Low based on the natural breaks classification method.
d. **Weight of Criteria:** each criterion was assigned an equal unit of weight concerning both the objective and with each other. The weights assigned are equal, as for this research, each criterion has equal influence in the riskiness of each zone.
e. **List the options:** the options refer to the class labels ranging from very high to very low.
f. **Rate the options:** the options were assigned ratings based on the classes defined for the risk zones.

The class labels developed based on the risk zone classification are:

a. **Very High** – the combination of values equal to 3/4 (e.g. 1+1+1)
b. **High** – the combination of values equal to 5/6 excluding the combination of 2+2+2

c. **Moderate** – the combination of values equal to 7 including the combination of 2+2+2

d. **Low** – the combination of values equal to 8 (e.g. 3+2+3)

e. **Very Low** – the combination of values equal to 9 (e.g. 3+3+3)

Figure 14 and Figure 15 shows the classification outcome of the risk zones based on MCDA.

Zone Code	Zone Name	Class Reclassification			Total Reclassifcation	Risk Zones
		Claim Incidence Density	Urbanization Level	Populaion Density		
0	City	3	1	2	6	High
1	Lasonder, Zeggelt	1	1	2	4	Very High
2	De Laares	1	1	2	4	Very High
3	De Bothoven	2	1	1	4	Very High
4	Hogeland-Noord	2	1	1	4	Very High
5	Getfert	3	1	1	5	High
6	Veldkamp-Getfert-West	1	1	2	4	Very High
7	Horstlanden-Stadsweide	3	2	2	7	Moderate
8	Boddenkamp	3	1	3	7	Moderate
10	Velve-Lindenhof	2	1	1	4	Very High
11	Wooldrik	2	2	3	7	Moderate
12	Hogeland-Zuid	1	1	1	3	Very High
13	Varvik-Diekman	3	2	3	8	Low
14	Sleutelkamp	3	2	3	8	Low
15	't Weldink	1	2	3	6	High
16	De Leuriks	1	3	3	7	Moderate
20	Cromhoffsbleek-Kotman	3	2	2	7	Moderate
21	Boswinkel-De Braker	2	1	1	4	Very High
22	Pathmos	1	1	1	3	Very High
23	Stevenfenne	2	1	1	4	Very High
24	Stadsveld-Zuid	2	2	1	5	High
25	Elferink-Heuwkamp	3	1	2	6	High
26	Stadsveld-Noord-Bruggert	1	2	2	5	High
27	't Zwering	2	2	2	6	Moderate
28	Ruwenbos	2	3	2	7	Moderate
30	Tubantia-Toekomst	3	1	2	6	High
31	Twekkelerveld	3	2	2	7	Moderate
40	Walhof-Roessingh	2	2	2	6	Moderate
41	Bolhaar	3	3	3	9	Very Low
42	Roombeek-Roomveldje	2	1	2	5	High
43	Mekkelholt	2	2	2	6	Moderate
44	Deppenbroek	2	2	1	5	High
45	Voortman-Amelink	3	3	3	9	Very Low
46	Drienerveld-U.T.	3	3	3	9	Very Low
50	Schreurserve	1	1	2	4	Very High

Figure 14: Classification Results of the Risk Zones Using MCDA (a)

51	Ribbelt-Ribbelerbrink	1	1	1	3	Very High
52	Park Stokhorst	2	2	2	6	Moderate
53	Stokhorst	3	3	3	9	Very Low
60	Stroinkslanden Noord-Oost	3	2	2	7	Moderate
61	Stroinkslanden-Zuid	3	2	2	7	Moderate
62	Stroinkslanden Noord-West	3	2	2	7	Moderate
63	Wesselerbrink Noord-Oost	3	2	2	7	Moderate
64	Wesselerbrink Zuid-Oost	2	1	1	4	Very High
65	Wesselerbrink Zuid-West	3	3	2	8	Low
66	Wesselerbrink Noord-West	3	2	2	7	Moderate
67	Helmerhoek-Noord	3	2	2	7	Moderate
68	Helmerhoek-Zuid	2	1	1	4	Very High
69	het Brunink	3	3	3	9	Very Low
70	Industrie- en havengebied	3	1	3	7	Moderate
71	Marssteden	3	2	3	8	Low
72	Koekoeksbeekhoek	3	3	3	9	Very Low
73	Kennispark	3	3	3	9	Very Low
80	Glanerveld	3	3	3	9	Very Low
81	Bentveld-Bultserve	3	2	2	7	Moderate
82	Schipholt-Glanermaten	2	1	2	5	High
83	Eekmaat	2	2	2	6	Moderate
84	Oikos	1	2	2	5	High
85	Eilermarke	2	2	2	6	Moderate
86	De Slank	3	1	3	7	Moderate
87	Dolphia	2	3	3	8	Low
88	Eekmaat West	2	2	2	6	Moderate
90	Dorp Lonneker	3	2	3	8	Low
91	Dorp Boekelo	3	3	3	9	Very Low
92	Buurtschap Lonneker-West	3	3	3	9	Very Low
93	Noord Esmarke	3	2	3	8	Low
94	Buurtschap Zuid-Esmarke	3	3	3	9	Very Low
95	Buurtschap Broekheurne	3	3	3	9	Very Low
96	Buurtschap Usselo	3	3	3	9	Very Low
97	Boekelerveld	3	3	3	9	Very Low
98	Buurtschap Twekkelo	3	3	3	9	Very Low

Figure 15: Classification Results of the Risk Zones Using MCDA (b)

4. IMPLEMENTATION

This chapter describes the incorporation of the analysis aforementioned in chapter 3 into the ERPNext. Development of used case scenarios illustrates the implementation of this incorporation with the outcomes and effect on decision making discussed in chapter 5.

4.1. Method Implementation

For the implementation of the processes discussed in chapter 3, an insurance module had to be created in ERPNext to obtain an ERP system that can ingest the insurance datasets generated. For this integration, forms are created on the insurance module to store insurance data obtained from policyholders. We implemented an ERPNext virtual box machine, because of the limitation of the operating system onto which ERPNext can be installed: Ubuntu, iOS, *NIX systems. The computer system used for this work was Windows, hence the need for a virtual installation of the ERPNext software. The steps used in the creation of the new app for Insurance in the ERPNext system included those described below.

i. <u>Production server download and set-up</u>

The production server was downloaded and setup. This was done by using Oracle's VirtualBox and installing the Production Image downloaded from EERPNext.org. The network of the VBM is set to Bridged adapter to ensure it has the same network as the host machine, as shown in Figure 16. On starting the server, the following credentials were used to run the ERPNext system.

```
username: frappe
password: frappe
mysql-root-password: frappe
```

On the console of the Virtual machine, ifconfig is used to determine the IP address of the host system to navigate to the Production Image for the ERPNext on the web browser. When the ERPNext has started the login details for the administrator are used to initialize the first launch of the ERPNext system.

```
user: Administrator
password: admin
```

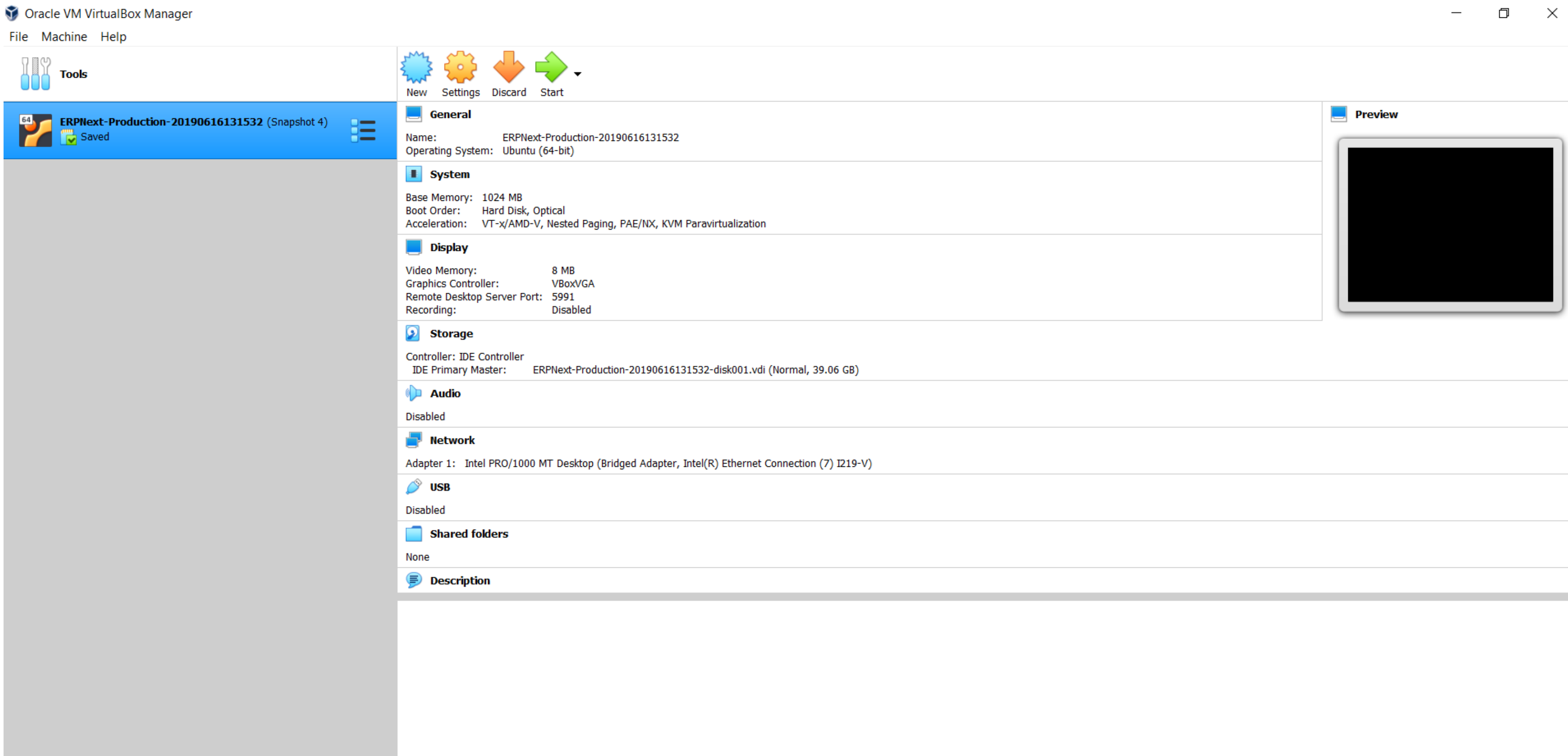

Figure 16: Virtual Machine for ERPNext

ii. New App Creation

A new app for the insurance module was built on the ERPNext system since it did not have any basic module to ingest the insurance data generated for the execution of the integration. The new app was created using the workbench of the virtual machine, which is the operating system that hosts the ERPNext. The code below was used to initiate the creation of the workbench.

```
bench new-app [your-app-name]
```

During the creation of the application, the following details were provided to build the metadata for the app.

- App name
- Short description of the app
- App publisher
- Email of the publisher
- App icon
- App colour
- Licence

The new app created was then installed in the single site for ERPNext Production Image (site1.local), and the workbench was restarted after the installation.

```
bench --site site1.local install-app [your-app-name]
bench restart
```

iii. Webpage Creation

On creating the insurance application in ERPNext, the folder containing all applications in ERPNext was accessed by downloading the Win-SCP software because the ERPNext used was hosted on a virtual server. The Win-SCP software helps with the navigation to the folder containing the details on the application created. In the www folder, the creation of the webpage for the application once developed was stored. Here the HTML, CSS, and other files used for creating the webpage is kept, and this folder is made publicly available on the web.

iv. Login to the Insurance web application

On the browser, the IP address for the host system was entered to launch the insurance application created. The browser used must be on the same network as the production image downloaded and installed for the ERPNext, as shown in Figure 17.

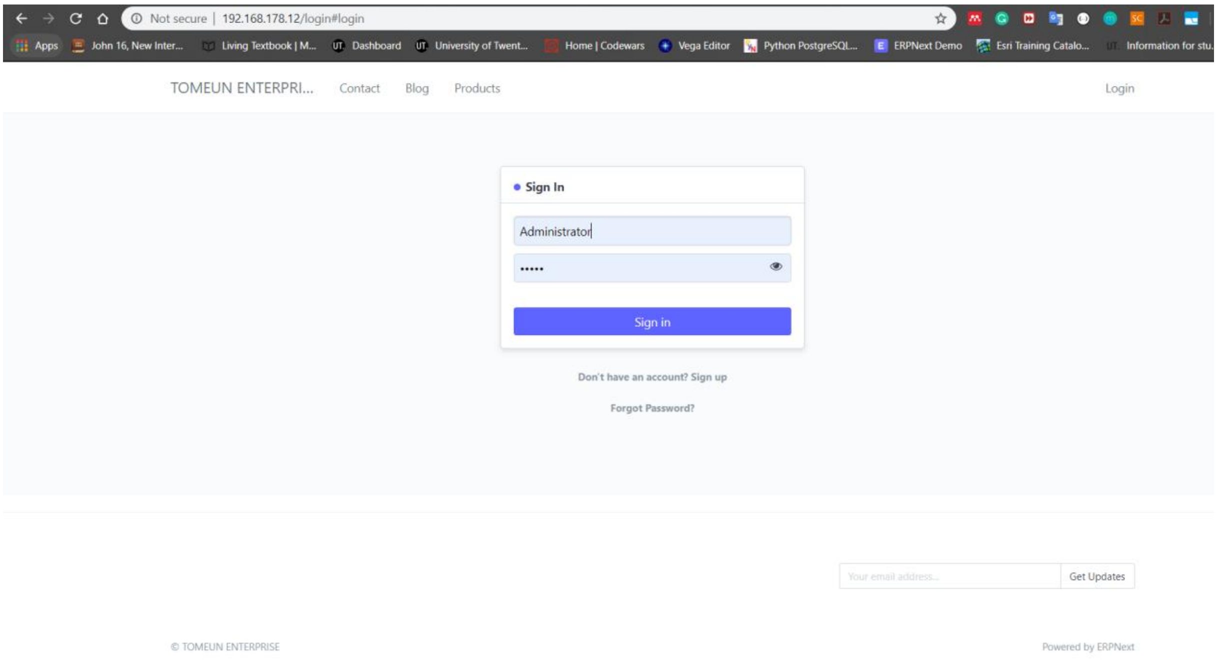

Figure 17: Administrative Login to the Insurance Application Module in ERPNext

The landing page on login in (Figure 18) shows the way the application has been created based on the developer's taste and use.

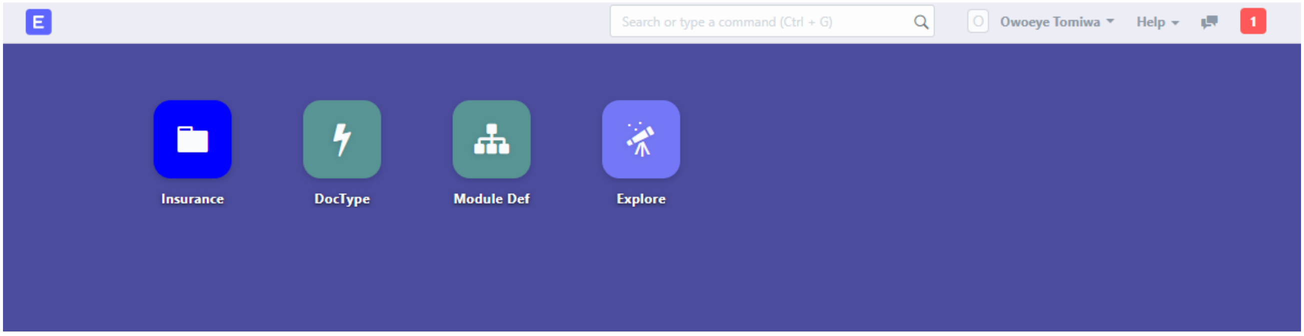

Figure 18: ERPNext Landing Page for Insurance Application

4.2. Data Integration

The datasets generated and processed were integrated into the insurance module created in the ERPNext, using the data integration features such as Doctype and Data Import in the ERPNext for creating and ingesting insurance data into the ERPNext. Doctype is a form and table representation of the insurance application created on the frappe bench, each doctype in the ERPNext serves as a REST API, which allows for the extension of a report generation and presentation. It makes use of field types for the generation of the content for each doctype specification (like the applicant, claims, customer and insurance zones doctypes). Table 4 provides the descriptions of these field types with the integration process enumerated below.

Table 4: Description of Doctype Field Types Adapted from ERPNext (2010)

S/N	Field Types	Description
1.	Attach	Browse and attach files from the file manager.
2.	Attach Image	Attach function specific to images (jpeg or png).
3.	Barcode	Specify barcode number to generate barcode upon selection.
4.	Check	Create checkbox for an attribute added.
5.	Code	Input code (programming language) upon selection.
6.	Colour	Specify the colour of the form created.
7.	Column Break	Column divider for a set of fields in the form created, to improve the layout.
8.	Currency	Hold numeric values like price, with a maximum of six decimal places. It has the currency symbol feature.
9.	Data	Input characters up to 140.
10.	Date	Specify the date.
11.	Datetime	Specify the computer current date and time.
12.	Dynamic Link	Hold document/doctype input with the capability to search.
13.	Float	Hold numeric values up to nine decimal with a precision section.
14.	Fold	Enlarges and collapses a set of fields.
15.	Geolocation	Stores spatial information (i.e. location) in GeoJSON feature collection format.
16.	Heading	Insert a title for the form.
17.	HTML	Input HTML format characters.
18.	HTML Editor	Input Markup Language.
19.	Image	Insert the relative path of the image for attachment.
20.	Int (Integer)	Specify numeric and non-decimal values.
21.	Link	Connects and fetches data from another doctype.

22.	Long Text	Input text with an unlimited character limit.
23.	Password	Specify a decoded value.
24.	Percent	Specify the percentage of values.
25.	Read Only	Fetches data from another form that can not be edited.
26.	Section Break	Divide forms into various sections for better beautification and eligibility.
27.	Select	Create a drop-down field for options.
28.	Small Text	Input text characters.
29.	Table	Specify another doctype into the current form created.
30.	Text	Input text character with the limit dependent on the relational database management system.
31.	Text editor	Input text character for defining terms and conditions.
32.	Time	Specify the time.
33.	Signature	Append digital signature.

i. Doctypes for the Insurance data were created in the insurance application hosted on ERPNext. The applicant, claims, customer and insurance zones doctypes were developed using the "Doctype" feature in the ERPNext, through the framework based on the attributes contained in each dataset as visualized in Figure 19.

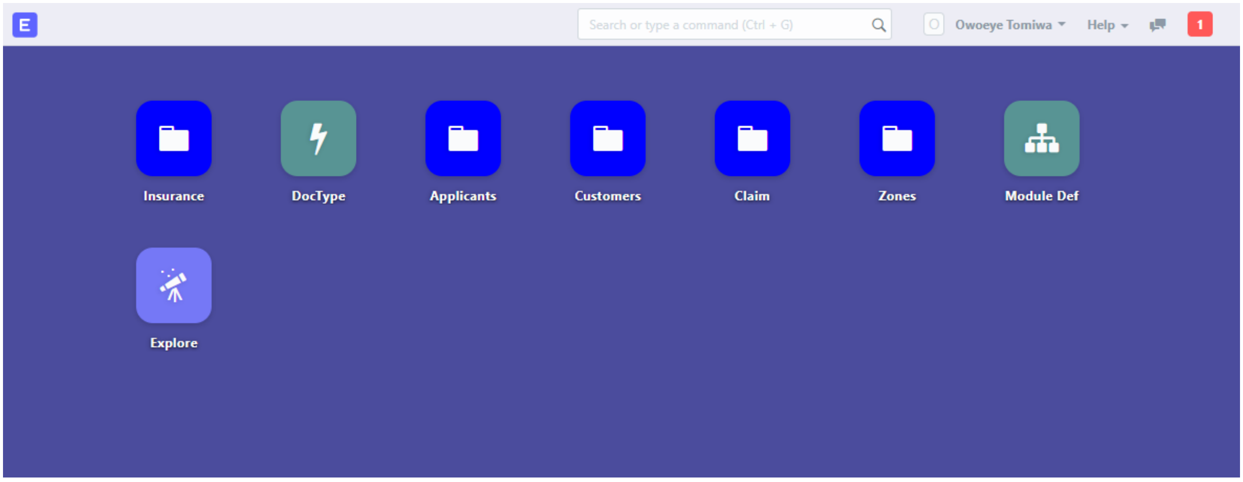

Figure 19: Insurance Application Landing Page With the Doctypes for the Insurance Data

ii. Templates for each doctype were created using the attributes of the insurance dataset and assigning the designated doctype field type to their respective attribute data type (see Figure 20).

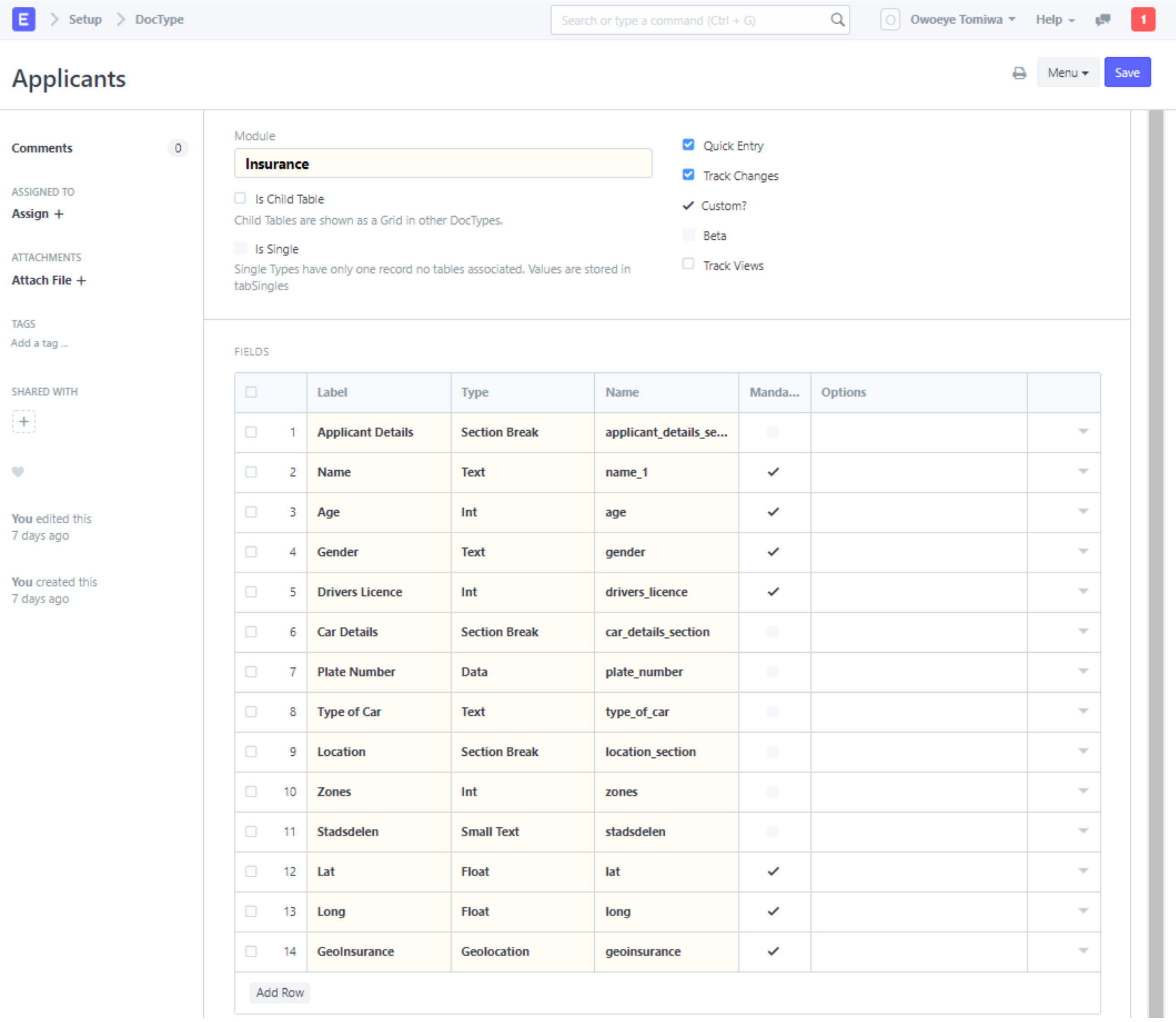

Figure 20: Template for Applicant Doctype

iii. The dataset for the doctypes created – Claims, Customer, Insurance zones and Applicants were imported via the Data Import feature in ERPNext. This data import was done by downloading the templates for all the doctypes and attaching them for upload to the Insurance application hosted on the ERPNext for populating the insurance database.

iv. During the data import process, there are two options for populating the doctype database. The first option is for the initial bulk upload of data records already generated by the insurance company using the "insert new records" selection (Figure 21). The second option is used for updating the already existing database with the option to either create new records under the existing ones or just to update them using the "update records" selection (Figure 22).

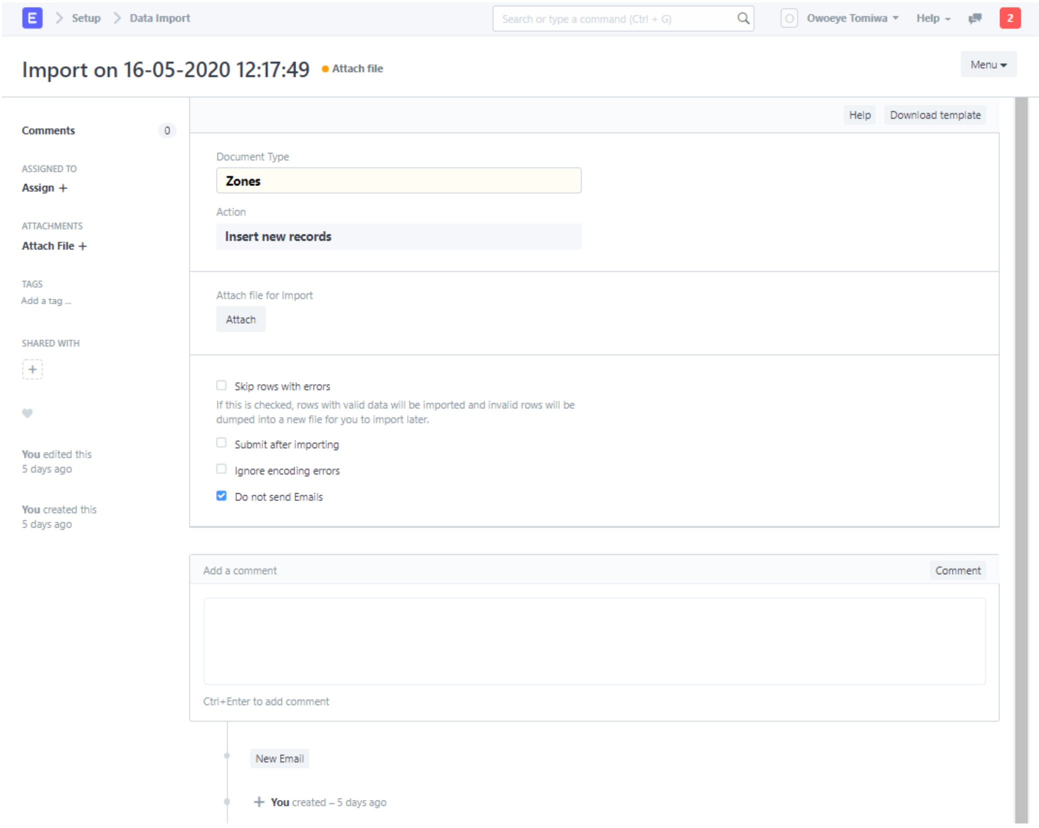

Figure 21: Data Import Template for Inserting New Records into the Zones Doctype

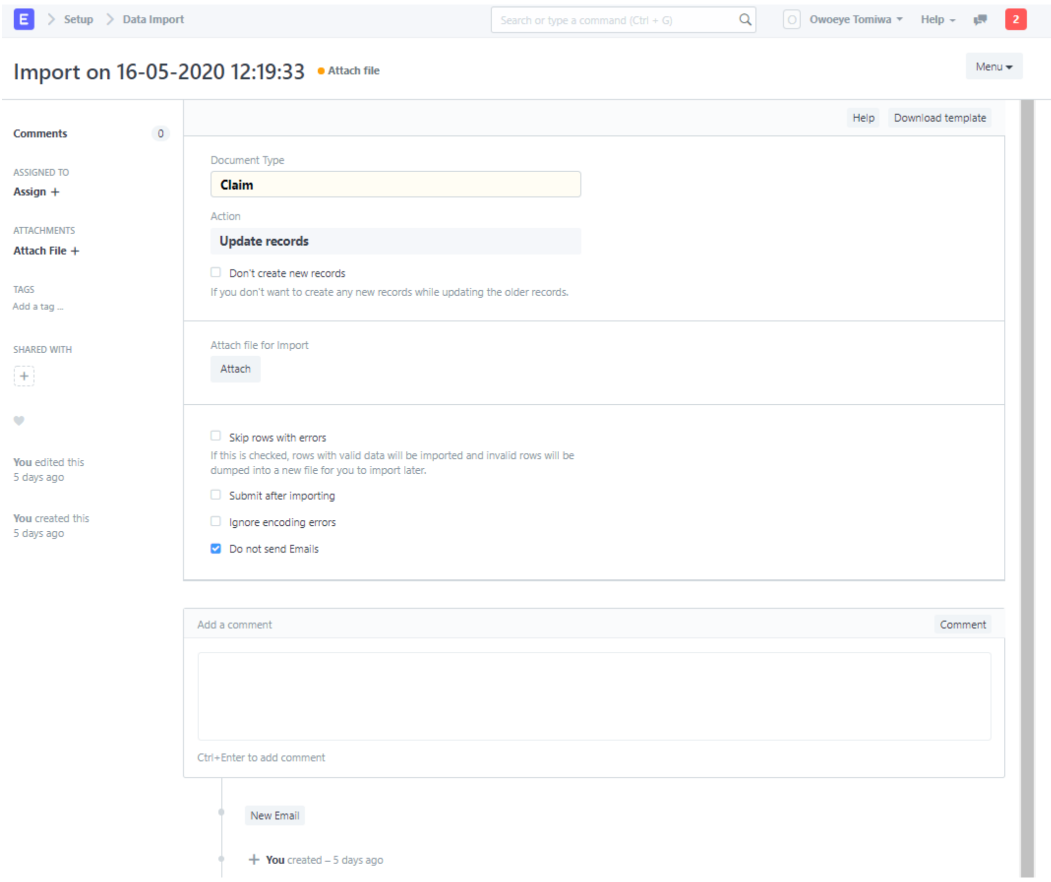

Figure 22: Data Import Template for Updating Records into the Claims Doctype

v. Each doctype had its database populated, and all addresses provided were correctly geolocated using the "Geolocation" field type to show the location of each insurance information, serving as the data entry for the models created in the insurance application (Figure 23 – Figure 25).

vi. On the ERPNext website created for the insurance application, the risk zones, claims and applicant information was visualized, to create an LI-enabled platform for rapid decision making by insurance brokers and claim managers on the premium estimation and claim reimbursements, respectively, amongst other decisions.

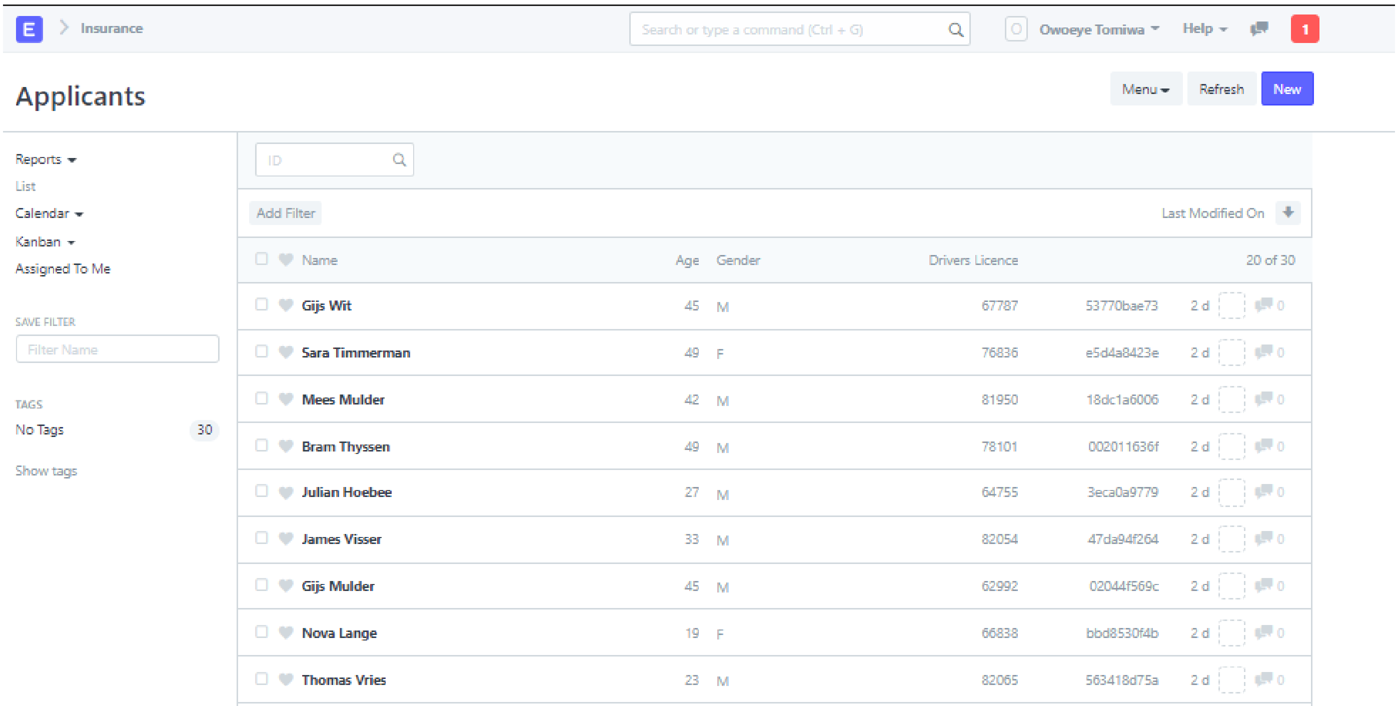

Figure 23: Imported Applicant Dataset

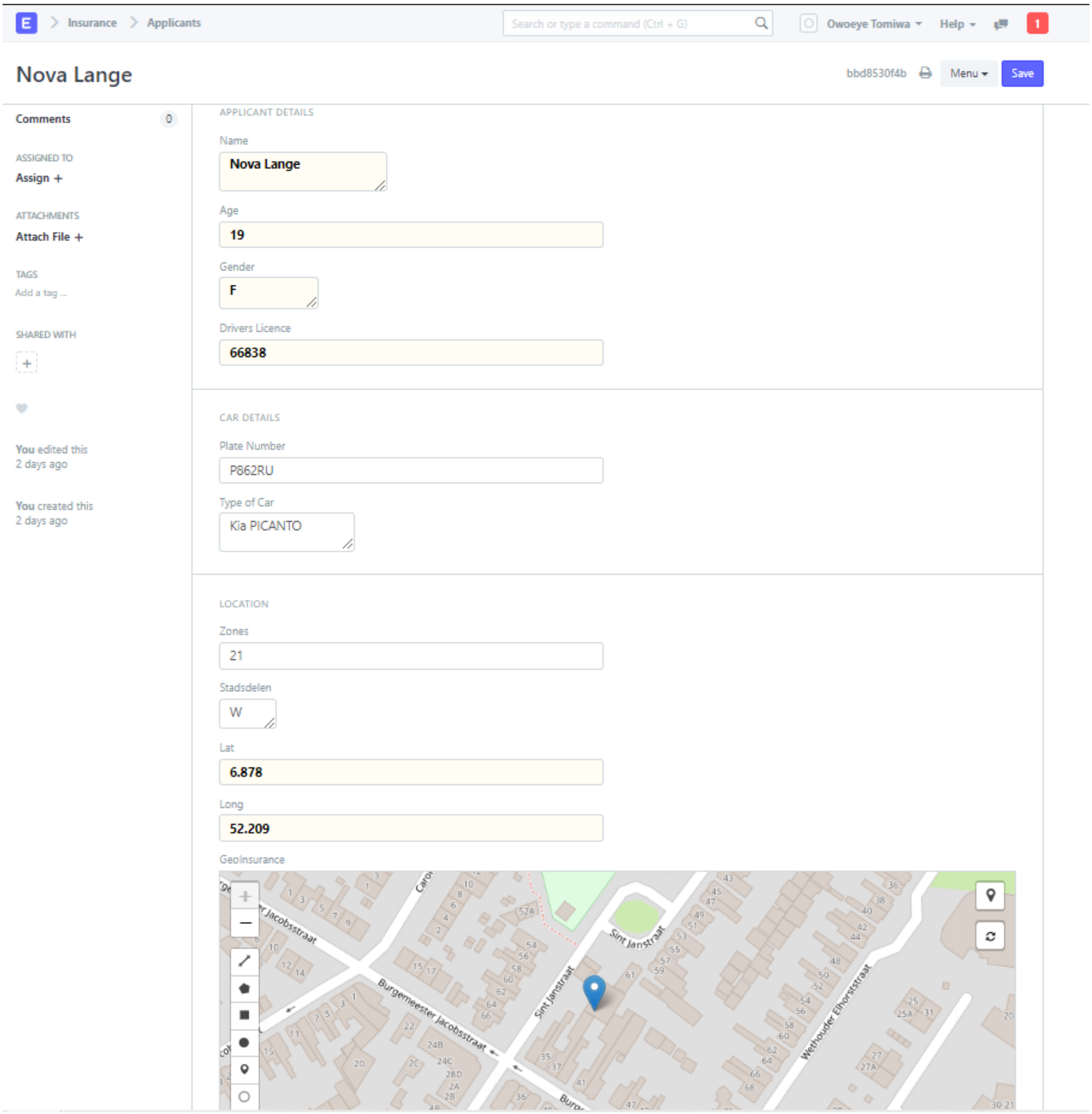

Figure 24: Data Entry Form for Applicants Records (a point geolocation feature type)

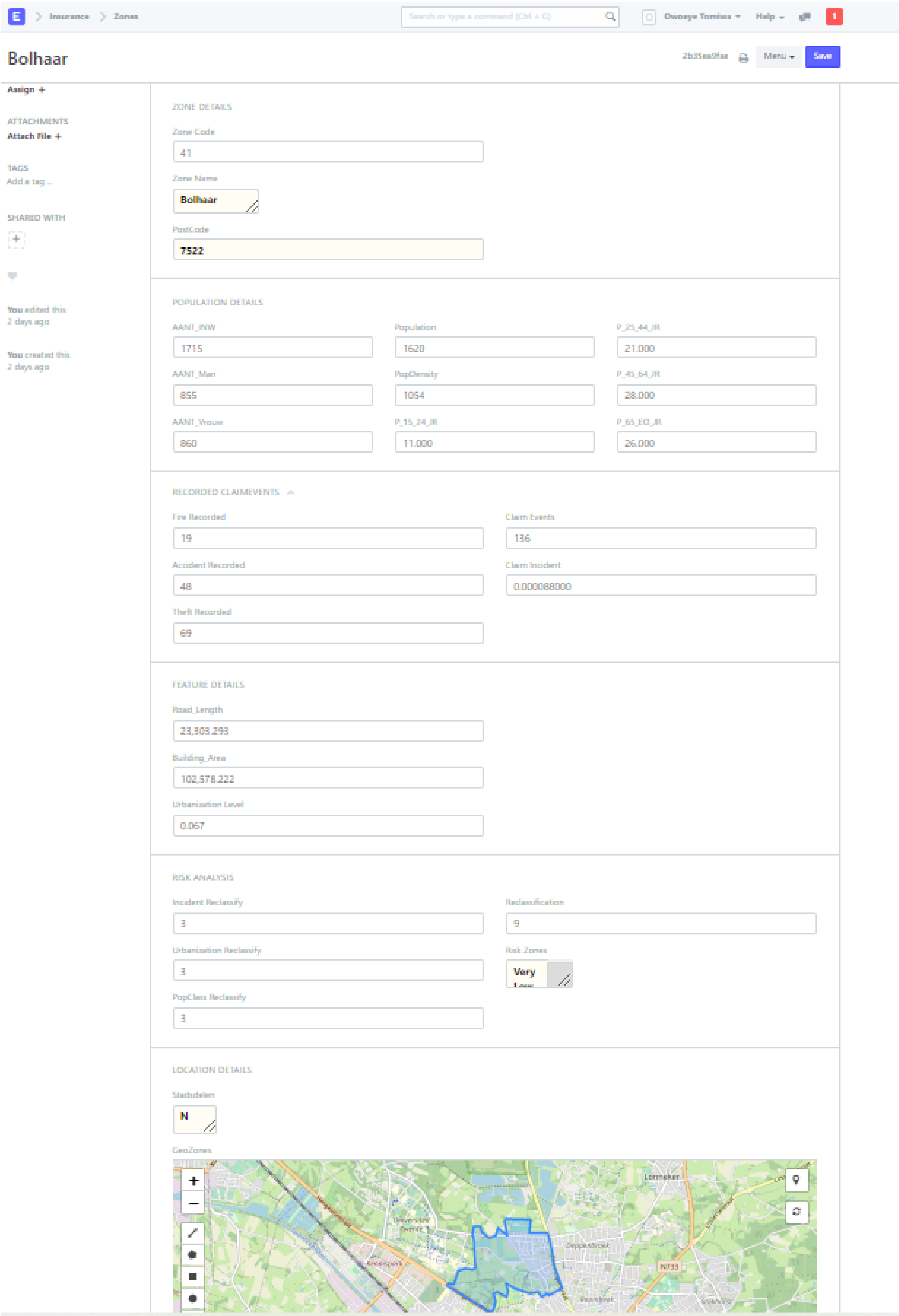

Figure 25: Data Entry Form for Insurance Zones Records (a polygon geolocation feature type)

4.3. Case Study

Use cases were developed to test the implementation of the LI integrated insurance BP in the insurance application created in the ERPNext. Two scenarios were created involving the application process and claims management, as this forms the initiation stage for two crucial insurance BPs: premium estimation and claim reimbursements. The case study was situated in both extremes of risk zones – very low (VL) and very high (VH) and shows the usage of the risk map created; reflecting the execution of the flowchart shown in Figure 11, with the outcomes illustrated in section 5.2. In setting up a new policy, the following processes are executed by the insurance company using the risk map created from the risk zones delineated in section 3.4:

i. The applicant sends his/her home address on filling the application form for a new car insurance policy.
ii. The location is checked against the risk zones.
iii. A buffer of 500–1500m is created around the applicant's address to create an estimate of travel distance (to work or groceries store) by car from the home location.
iv. Whenever the location and buffer fall within some risk zone, this will influence the estimation of the premium payable by the applicant in addition to other factors such as age, gender, type of car and driving history.

Scenario 1

Two applicants located at VH and VL with 500–1500m buffer zone were used to illustrate the minimum and maximum travel distances of the driver from the home location with the dangerous routes visualized (i.e. the major roads). The outcome of this scenario illustrated in Figure 28 is used in the estimation of premium. This shows the ranges of the risk areas which can be travelled. The variables used for constructing this scenario is described in Table 5.

Table 5: Descriptions of the Variables Used in Creating the Applicant Scenario

S/N	Applicant Scenario Variables	Description
1.	A_Roads_VL	Major roads within a 1500m buffer distance from the applicant's home located in a very low-risk zone
4.	A_Roads_VH	The major roads within a 1500m buffer distance from the applicant's home location situated in a very high-risk zone
7.	Applicant_VL_500	A 500m buffer radius from the home location of the applicant located in a very low-risk zone
8.	Applicant_VL_1000	A 1000m buffer radius from the home location of the applicant located in a very low-risk zone
9.	Applicant_VL_1500	A 1500m buffer radius from the home location of the applicant located in a very low-risk zone

10.	Applicant_VH_500	The 500m buffer radius from the home location of the applicant sited in a very high-risk zone
11.	Applicant_VH_1000	A 1000m buffer radius from the home location of the applicant situated in a very high-risk zone area
12.	Applicant_VH_1500	The 1500m buffer radius from the home location of the applicant located in a very high-risk zone

Scenario 2

Scenario 2 is related to claims management. It involves the selection of two claim submissions situated at VH and VL risk zones to visualize and calculate the likelihood in the frequency of claims which may be submitted as a result of the range of risk zones covered from travel distance between 500–1500m of the customer's home location. Since claims are not always submitted at the point of incidence, the insurance application takes into consideration the possibility for the claim requestor to fill in the address in which the incidence took place for the location details to be processed accordingly. Table 6 describes the claim variables used for producing the scenario.

Table 6: Descriptions of the Variables Used in Creating the Claims Scenario

S/N	Claims Scenario Variables	Description
1.	Roads_VH	The major roads within a 1500m buffer distance from the location of the claim submitted that is situated in a very high-risk zone.
4.	Roads_VL	The major roads within a 1500m buffer distance from the location of the claim submitted in a very low-risk zone.
7.	Claim_VH_500	The 500m buffer radius from the point location of the claim sited in a very high-risk zone.
8.	Claim_VH_1000	A 1000m buffer radius from the position of the claim submitted in a very high-risk zone area.
9.	Claim_VH_1500	A 1500m buffer radius from the claim presented which is located in a very high-risk zone.
10.	Claim_VL_500	The 500m buffer radius from the claim proposed situated in a very low-risk zone.
11.	Claim_VL_1000	A 1000m buffer radius from the site where the claim was submitted in a very low-risk zone.
12.	Claim_VL_1500	The 1500m buffer radius from the location of the claim submitted in a very low-risk zone.

5. RESULT AND DISCUSSION

5.1. Implementation Results

Having executed the integration of the LI-enabled insurance BP into the insurance application developed on the ERPNext, a risk map was produced from processing the risk zones using MCDA; the criterion is assigned equal weights, and this may differ from places to places based on the influence of each criterion to the overall risk level within the zones. A single risk map was developed because all criteria were assigned equal weights for this implementation; it visualizes the level of risk in each zone based on the results obtained from the criteria:

i. Claim Incidence Level: showing the range from low – high, the incidence density per zone
ii. Urbanization Level: indicating the range from low – high, the level of built-up areas per zone
iii. Pop-class: consists of the range from low – high population density per zone

The risk map derived revealed the very high to very low risk areas within Enschede, with many data it might be possible to discriminate between the claim event types per risk zone but for this study, all claim types were harmonized and categorized into 3; theft, accidents and fire. It can be seen from Figure 26 that the centre of the city tends to be riskier based on how busy the centre is. The risk map layout used for decision making by the insurance company can be achieved by overlaying the insurance datasets, as shown in Figure 27. Table 7 provides the zones codes and their respective names.

Table 7: Description of the Zone Codes and Their Respective Names.

Zone Code	Zone Name	Zone Code	Zone Name
0	City	51	Ribbelt-Ribbelerbrink
1	Lasonder, Zeggelt	52	Park Stokhorst
2	De Laares	53	Stokhorst
3	De Bothoven	60	Stroinkslanden Noord-Oost
4	Hogeland-Noord	61	Stroinkslanden-Zuid
5	Getfert	62	Stroinkslanden Noord-West
6	Veldkamp-Getfert-West	63	Wesselerbrink Noord-Oost
7	Horstlanden-Stadsweide	64	Wesselerbrink Zuid-Oost
8	Boddenkamp	65	Wesselerbrink Zuid-West
10	Velve-Lindenhof	66	Wesselerbrink Noord-West
11	Wooldrik	67	Helmerhoek-Noord
12	Hogeland-Zuid	68	Helmerhoek-Zuid
13	Varvik-Diekman	69	het Brunink

14	Sleutelkamp	70	Industrie- en havengebied
15	't Weldink	71	Marssteden
16	De Leuriks	72	Koekoeksbeekhoek
20	Cromhoffsbleek-Kotman	73	Kennispark
21	Boswinkel-De Braker	80	Glanerveld
22	Pathmos	81	Bentveld-Bultserve
23	Stevenfenne	82	Schipholt-Glanermaten
24	Stadsveld-Zuid	83	Eekmaat
25	Elferink-Heuwkamp	84	Oikos
26	Stadsveld-Noord-Bruggert	85	Eilermarke
27	't Zwering	86	De Slank
28	Ruwenbos	87	Dolphia
30	Tubantia-Toekomst	88	Eekmaat West
31	Twekkelerveld	90	Dorp Lonneker
40	Walhof-Roessingh	91	Dorp Boekelo
41	Bolhaar	92	Buurtschap Lonneker-West
42	Roombeek-Roomveldje	93	Noord Esmarke
43	Mekkelholt	94	Buurtschap Zuid-Esmarke
44	Deppenbroek	95	Buurtschap Broekheurne
45	Voortman-Amelink	96	Buurtschap Usselo
46	Drienerveld-U.T.	97	Boekelerveld
50	Schreurserve	98	Buurtschap Twekkelo

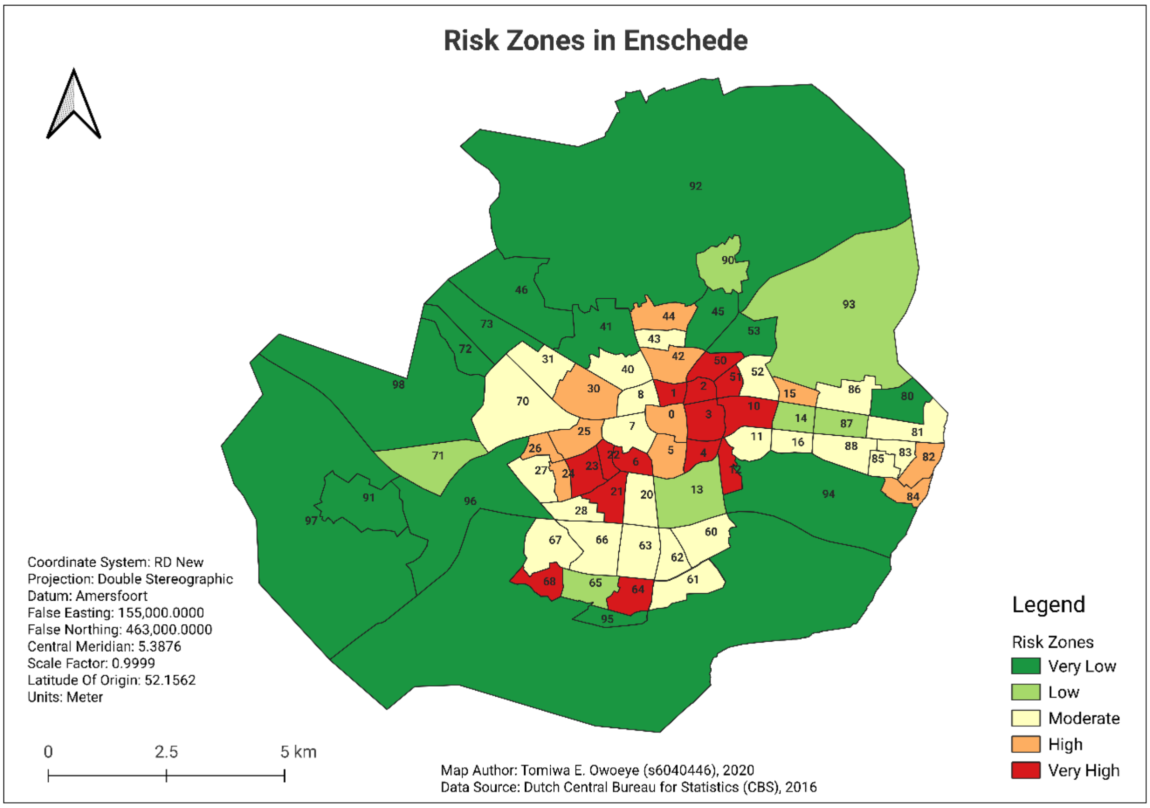

Figure 26: Map Showing the Classification of Risk Zones in Enschede

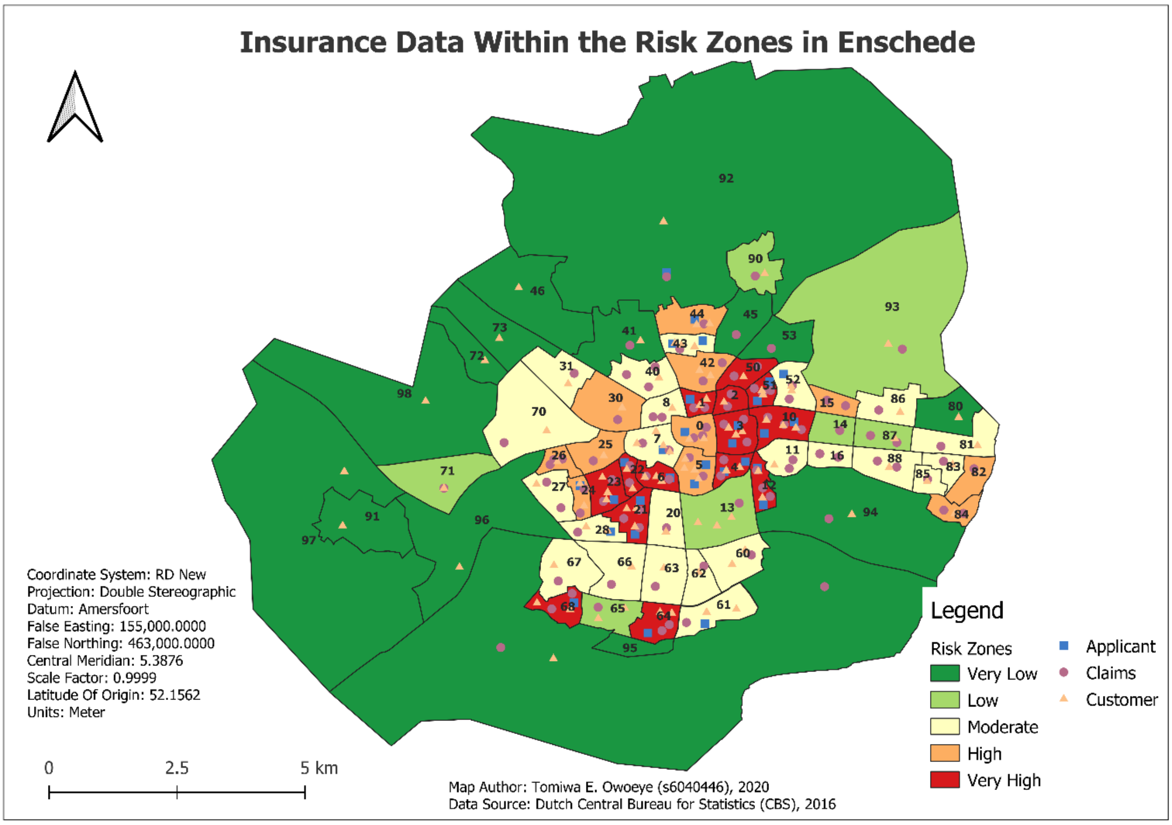

Figure 27: Map Showing the Distribution of the Insurance Data Within the Risk Zones in Enschede

With the use of the risk map, there is a better way to estimate premiums for new applicants as well as verify, manage and flag fraudulent claims. Since insurance can be used for the realisation of "urban resilience", it can, therefore, be said that the more an urbanised area, the higher the probability of obtaining insurance policy and submitting a claim. This proves that risky zones influence the number of insurance policies purchased as the inhabitants is more likely to insure their properties, and this affects the premium calculation of the applicants and recalculation for the customers within those zones as they are likely to make claims within a year (Felsenstein et al., 2018).

Figure 27 shows that there are indeed more applicants, customers and claims submitted within the risky areas (i.e. between the high and very high-risk zones). The use of maps like this has an added advantage to society, as with the right premium estimation and increase in the customer database for the insurance company, it is seen as an essential ingredient in risk mitigation and reduction in society. A positive correlation exists between the risk level in the home address of the drivers and the rate of car insurance purchased. This correlation occurs because the drivers who are liable to more accidents either as a result of behaviour or locality tend to get a more expensive insurance policy ensuring adequate risk coverages and also tend to submit the highest number of claims as well due to more claim incidents like road accidents (Hsu et al., 2016).

5.2. Case Study Results

The outcomes of the case study are shown in Figure 28 and Figure 29 which represents the scenarios created for both applicants and claims submitted, respectively. Two random applicants were selected to illustrate the effect of having an application submitted within very high and very low-risk zones using the risk map produced. The benefits of the risk map from the applicant's perspective are enumerated below.

i. On filling the application form, the applicant gets an estimate of the premium payable per zone.
ii. Based on the location filled in by the customer, this enables the customer to have a guestimate and understand the procedures and calculation undertaken during the evaluation of the premium, receiving a justification for the amount to be paid in advance.

Due to the analysis made, the customer located within a zone with relatively lower risk level will most likely be offered a lower premium to pay. In case of an increase in the estimated number of claims per customer based on the risk zones travelled, to improve the efficiency of claim management.

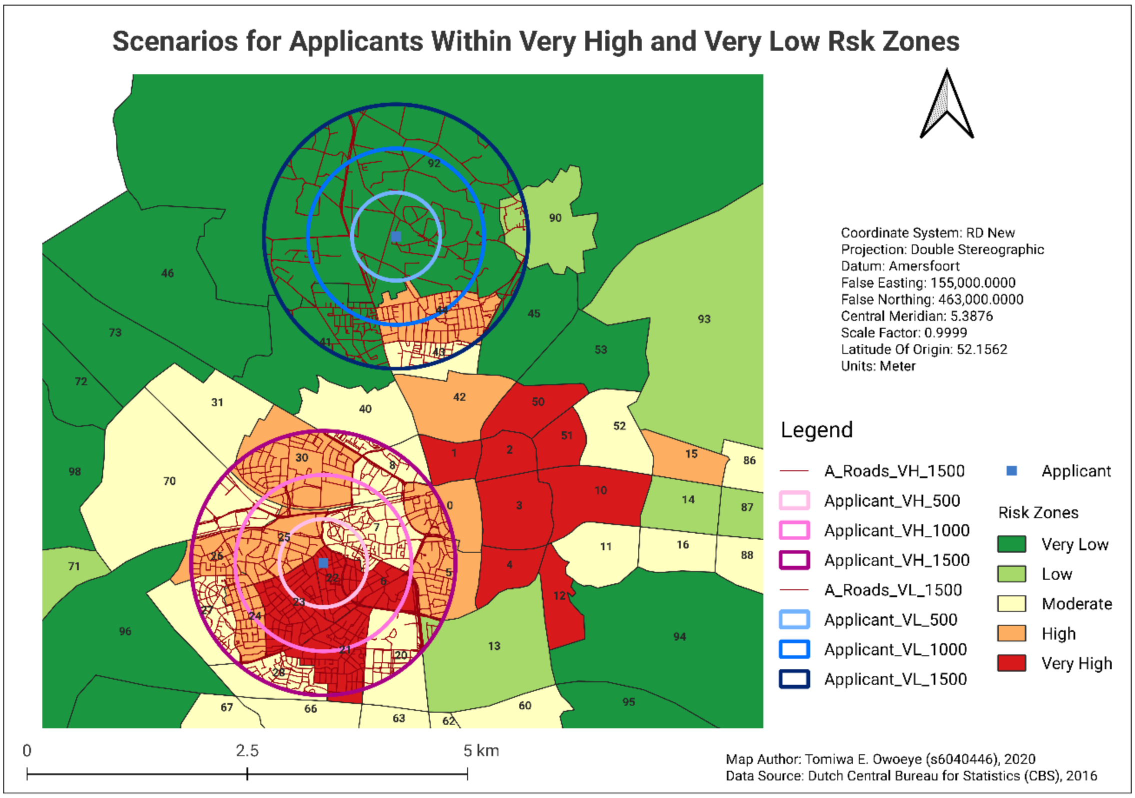

Figure 28: Applicant Scenario for the Application Submitted Within Very Low and Very High Risk Zones

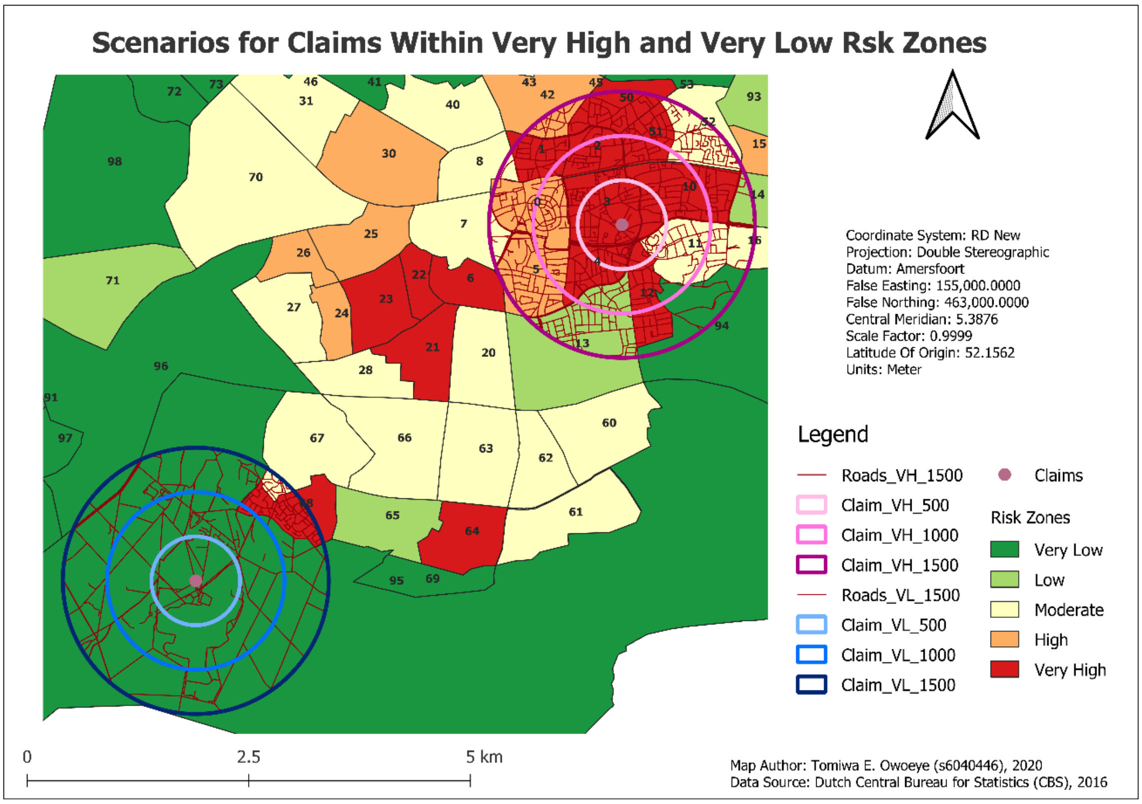

Figure 29: Scenario for Claims Submitted Within Very Low and Very High Risk Zones

The buffer contains an estimate of the travel distance and the likelihood for an application and claim request within the travel distance of up to 1500m from their home location. It shows the current claim that has been submitted (an example of claims in the very low and high-risk zones). It also refers to an applicant submitting an application within the claimed risked zone is likely to request for a claim in the future. The likelihood of the request for a claim is higher within very high-risk zones and lower within very low-risk zones. Here, there can be a discount given based on the risk level of the zones in which claims are requested, or applications are submitted. The risk map also shows the home address of the policyholder and the location where the claim event transpired. In the probability that claims submitted in the lower risk zones become higher than envisaged, there has to be an investigation carried out to find out the reasons behind the increase in claims requested.

In both claim and applicant scenarios, the roads within the buffer zones are the major roads these are likely to be travelled frequently and will probably be amongst the more dangerous routes travelled as well. Based on the address and postcode given during the compilation of the insurance data, all the location details were geocoded to get their spatial information. With the applicant, customer and claim information from the forms, only the location details were generated, with other details were given either by the applicant or customer during the application or request for a claim.

5.3. LI Enterprise System

From the insurance web application created in section 4.1, the leading website was developed into an LI-enabled enterprise system designed for the execution of insurance BP. The risk zones were displayed on the web application and launched live using the "MiwaInsurance" GitHub page.

a) Homepage

The header in the homepage (Figure 30) of the enterprise system contains information about the products, the name of the company which the enterprise belongs to, the information about the enterprise system as illustrated in Figure 31. The products (see Figure 33), which contain final maps visualising the major processes undergone during the implementation with contact details for more enquires about the insurance system shown in Figure 32.

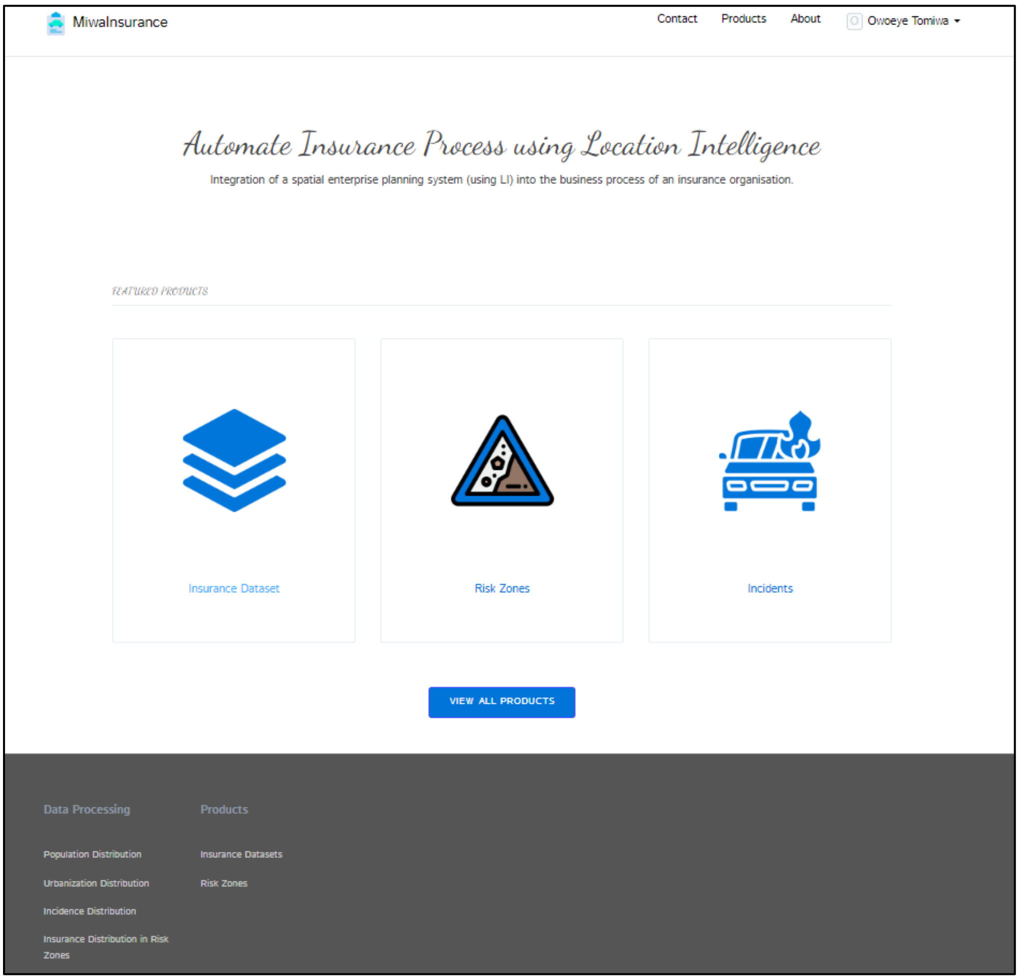

Figure 30: Landing Page of the LI-enabled Insurance Enterprise System

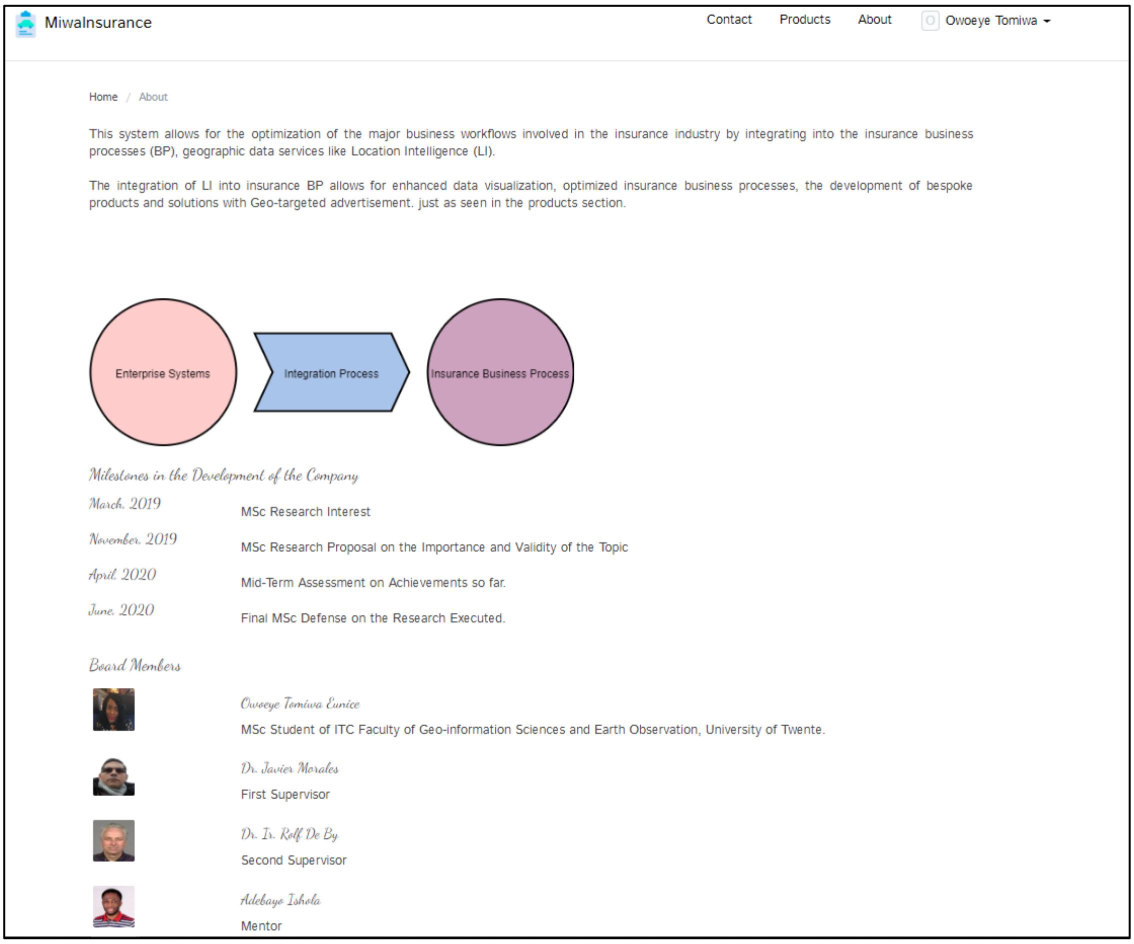

Figure 31: The About Page for the LI-enabled Insurance Enterprise System

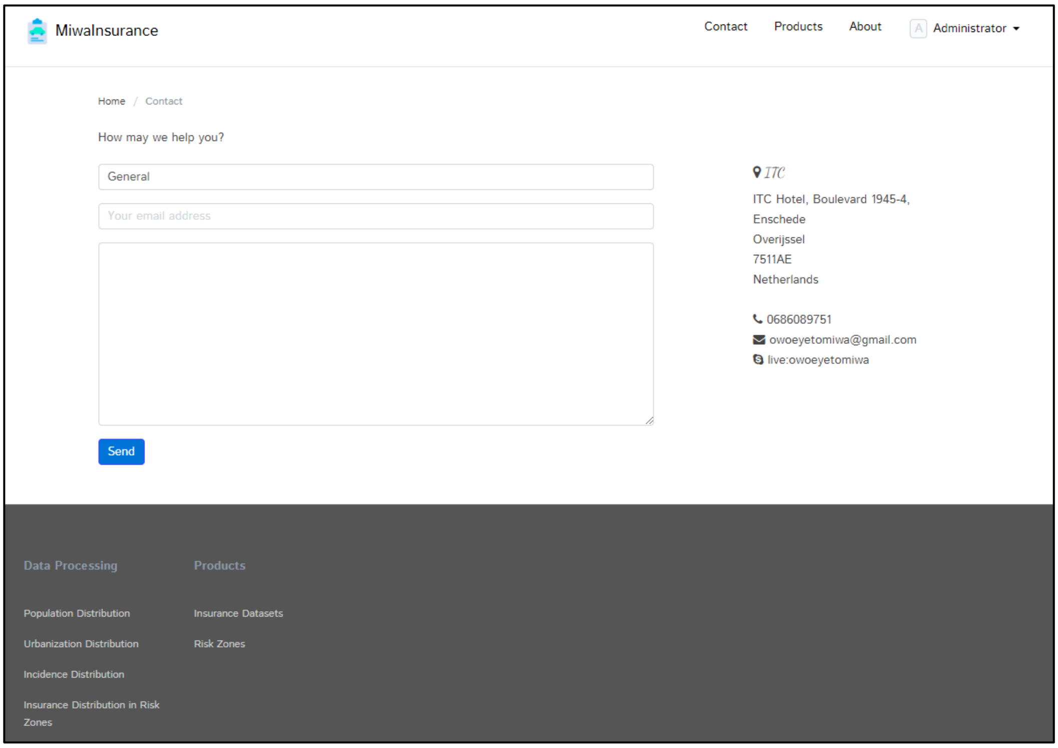

Figure 32: Contact Page for the LI-enabled Insurance Enterprise System

b) Products Page

The products page visualizes all the final information derived as discussed in sections 4.1 and 4.2, with an overview detailing the description of the maps. Figure 34 provides a snapshot of this feature. The footer in the homepage of the system provides a weblink which executes the REST API used for processing data for the implementation of the website application for insurance on the ERPNext.

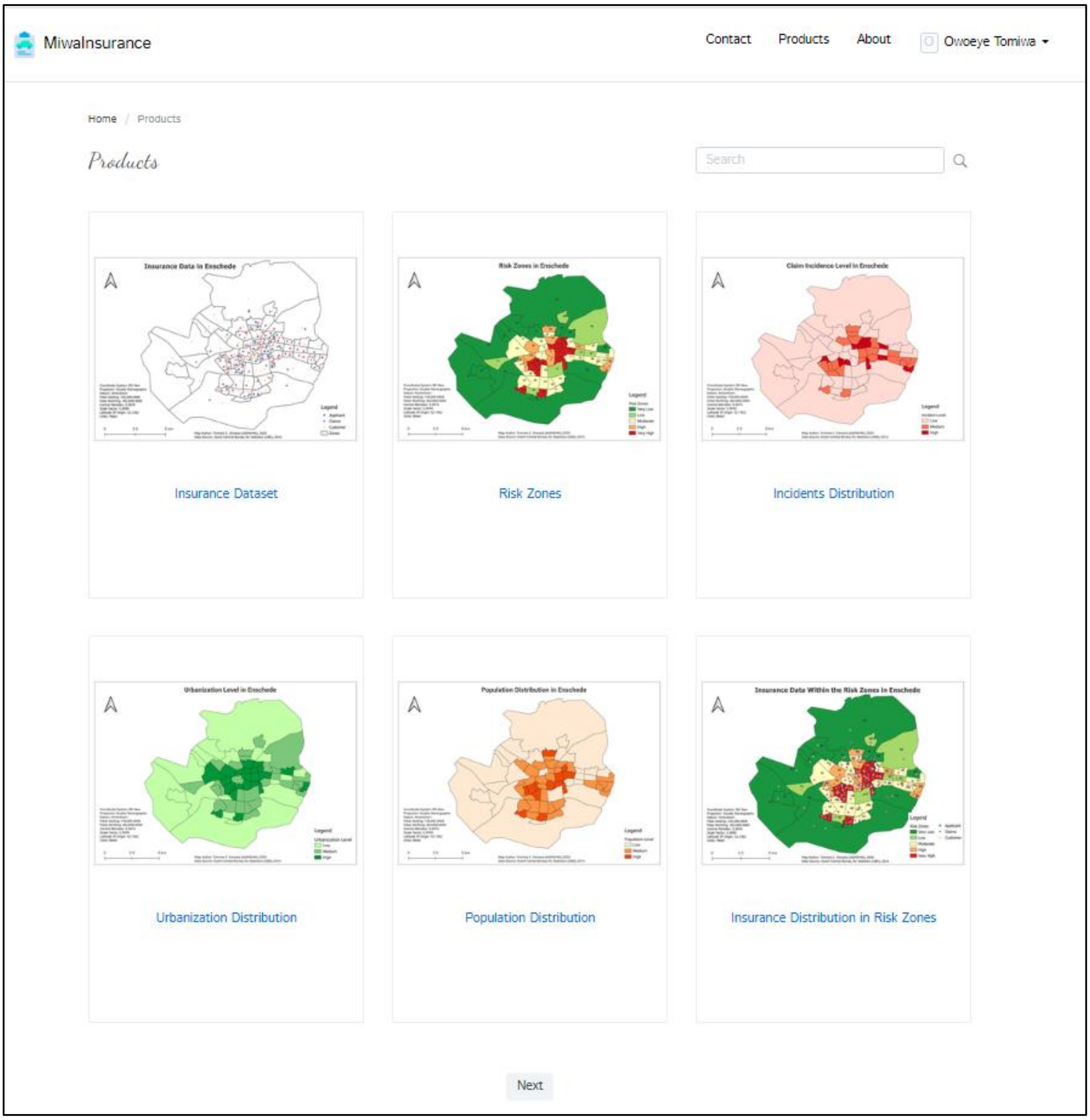

Figure 33: Overview of the Products Developed in the Enterprise System

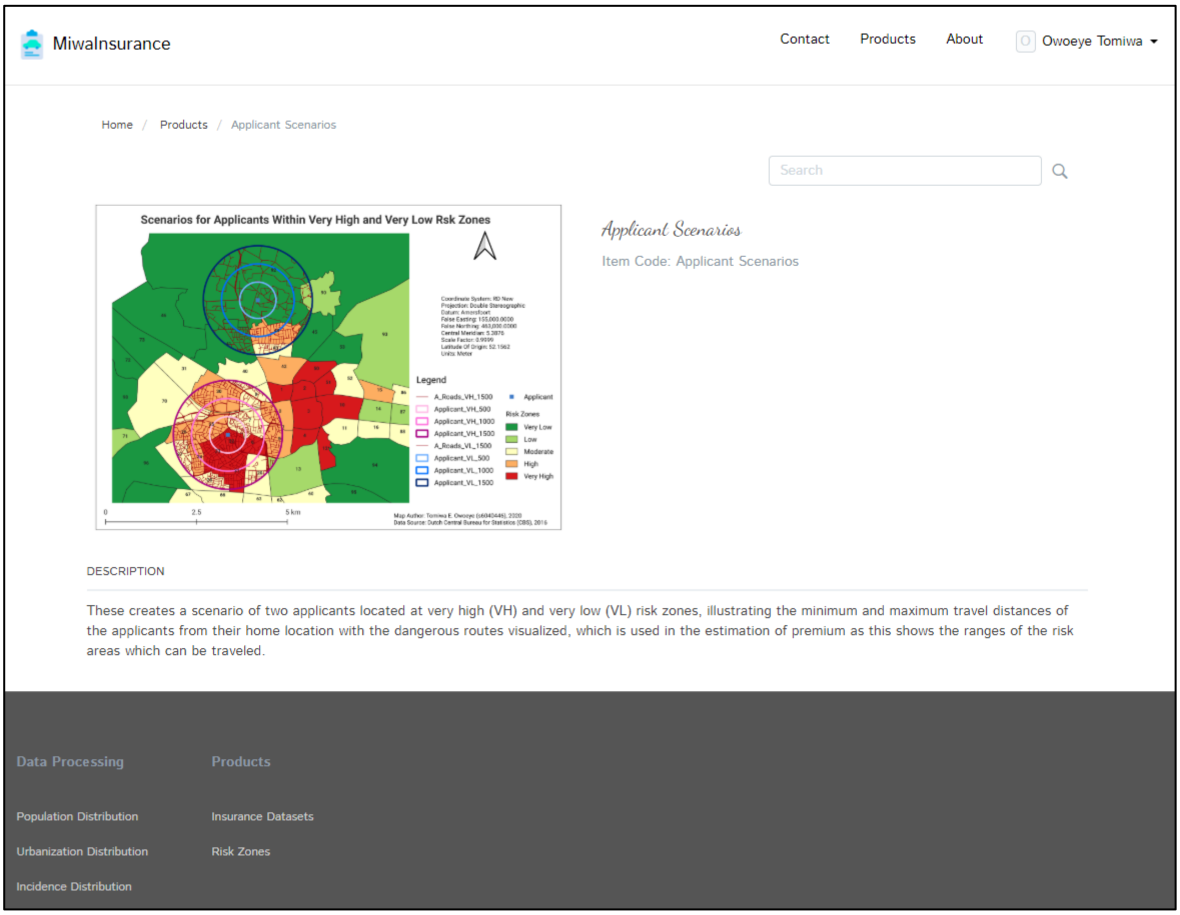

Figure 34: Product Overview Webpage

c) <u>Webpage Content</u>

Table 8 gives an overview of the REST API designed for the data processed with corresponding response information. The JSON result acquired from the REST API was parsed into the scripts used for designing the insurance enterprise system as data just as represented in Figure 35. All the data and scripts derived during the implementation were stored in the WinSCP for easy access by the enterprise system when a call is made, Figure 36 illustrates the folder layout which was used for the integration of the insurance datasets into the ERPNext during the development of the insurance application.

Table 8: List of REST API Used for Data Processing in the Insurance Application

S/N	REST API Address	Response Description
1.	http://130.89.174.19/api/resource/Applicants?fields=["*"]&limit_page_length=1000	Get all the Applicants data (including geometry) contained in the ERPNext database.
2.	http://130.89.174.19/api/resource/Zones?fields=["*"]&limit_page_length=1000	Get all the Zones data(including geometry) contained in the insurance

		application.
3.	http://130.89.174.19/api/resource/Customers?fields=["*"]&limit_page_length=1000	Get all the Customer information, including geometry stored in the ERPNext database.
4.	http://130.89.174.19/api/resource/Claim?fields=["*"]&limit_page_length=1000	Get all the Claims requested for and stored within the insurance application with their geometrical attributes.
5.	http://130.89.174.19/api/resource/Claim?filters=[["zones","=",3]]&fields=["*"]&limit_page_length=1000	Get an example of a claim requested within one of the very high risk zones.
6.	http://130.89.174.19/api/resource/Applicants?filters=[["zones","=",94]]&fields=["*"]&limit_page_length=1000	Get an example of applicant information situated within one of the very low risk zones.


```
{
"data": [
{
"name_1": "Luuk Teuling",
"stadsdelen": "O",
"creation": "2020-05-17 12:50:39.740358",
"zones": 12,
"owner": "Administrator",
"type_of_car": "Opel KARL",
"modified_by": "Administrator",
"_user_tags": null,
"long": 52.214013,
"plate_number": "Z756LA",
"idx": 0,
"docstatus": 0,
"_liked_by": null,
"parent": null,
"_assign": null,
"lat": 6.911663,
"geoinsurance": "{\"type\":\"FeatureCollection\",\"features\":[{\"type\":\"Feature\",\"geometry\":{\"type\":\"Point\",\"
"_comments": null,
"name": "d7b5186058",
"drivers_licence": 73640,
"gender": "M",
"age": 28,
"modified": "2020-05-17 12:50:39.740358",
"parenttype": null,
"parentfield": null
},
```


Figure 35: Snippet of the JSON Response from the Applicant REST API

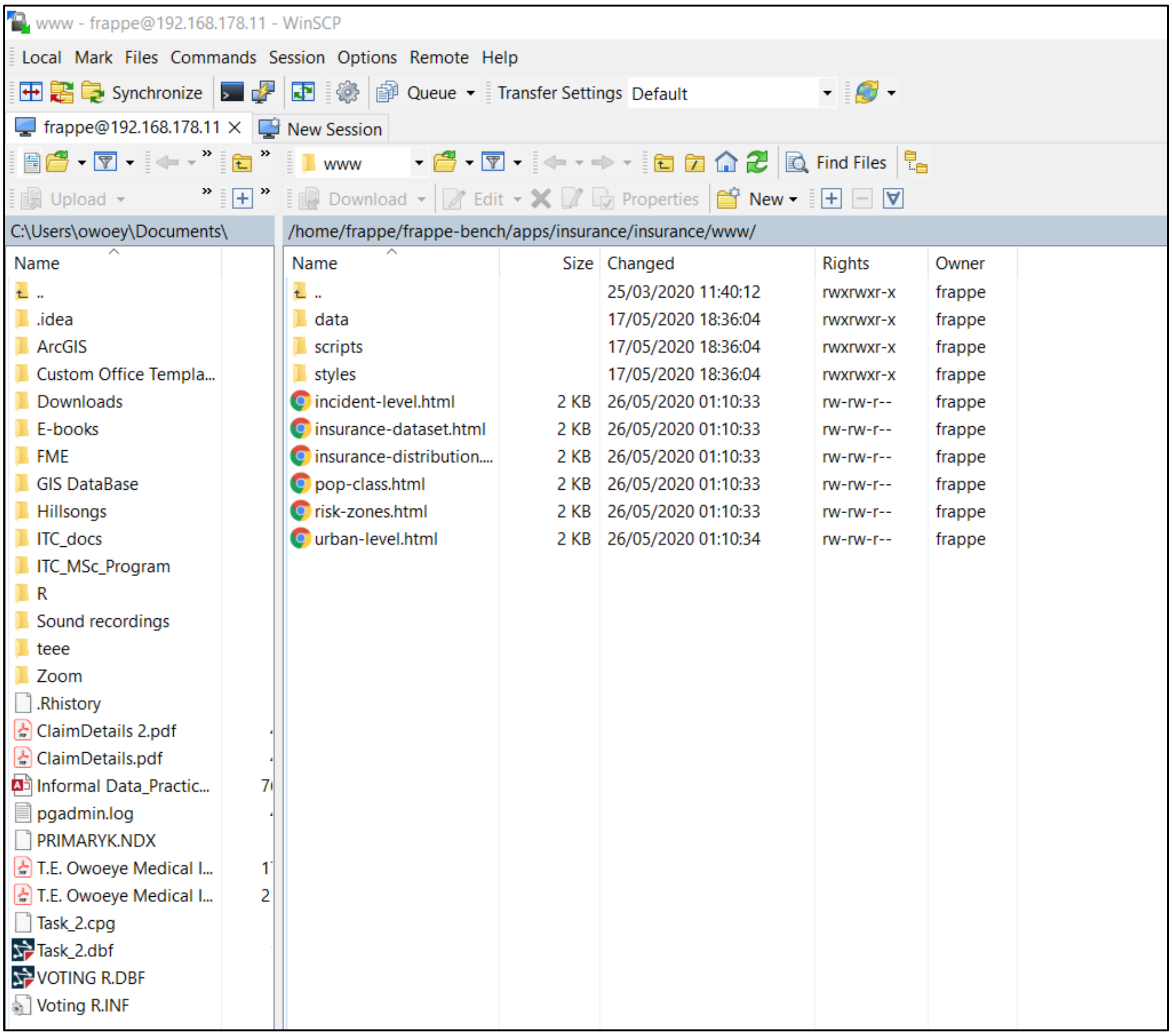

Figure 36: WinSCP Showing the Data and Scripts Used for Designing the Insurance Enterprise System

The insurance enterprise system was created using HTML, CSS and JS files. Data processes such as the visualization of risk zones within Enschede and the distribution of the insurance dataset were executed in the system using the personalised scripted features provided on "InsuranceERPNext" GitHub page. Full scripts and data used for executing these processes are provided in Table 9 which contains URLS to be followed and are also appended in the Appendix section.

Table 9: URLs to the Scripts Used for Designing the Insurance Enterprise System

S/N	URLs	Description
1.	https://github.com/tomiwa-eunice/InsuranceERPNext/blob/master/data/Applicant.json	JSON response from the Applicant REST API.
2.	https://github.com/tomiwa-eunice/InsuranceERPNext/blob/master/styles/style.css	CSS code used for designing the enterprise system.

3.	https://github.com/tomiwa-eunice/InsuranceERPNext/blob/master/scripts/risk-zones.js	JS code used for processing Risk Zone data within the enterprise system.
4.	https://github.com/tomiwa-eunice/InsuranceERPNext/blob/master/insurance-dataset.html	HTML code used for the insurance dataset page in the enterprise system.

d) <u>Data Processing Page</u>

The data processing page shows the processes carried out using the REST API such as in Figure 37, which shows the dynamic landing webpage of the risk zones with the pop-up containing the information drawn from the insurance database stored in the ERPNext and a toggle for the layers visible in the webpage with the legend explaining each symbol on the webpage. A brief overview is given for each data processing landing webpage with a navigation button to return to the previous page or homepage of the enterprise system.

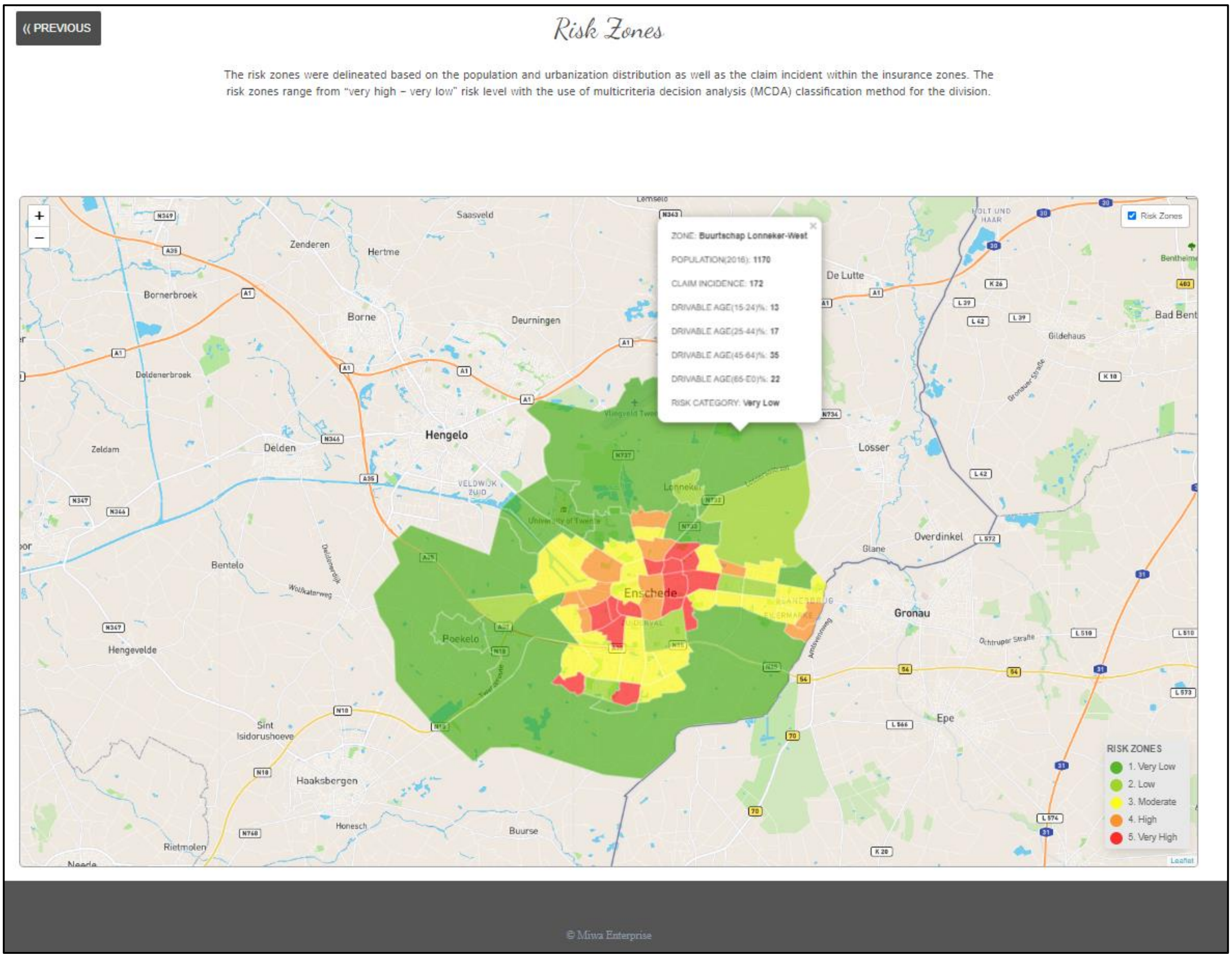

Figure 37: Dynamic Landing Webpage for Processing the Risk Zones

In Figure 38 the toggle buttons are aligned with the number of layers visualized in the data processing for the insurance dataset distribution within the risk zones, with this button the user (i.e. insurance company) can decide on the information shown depending on the decision taken.

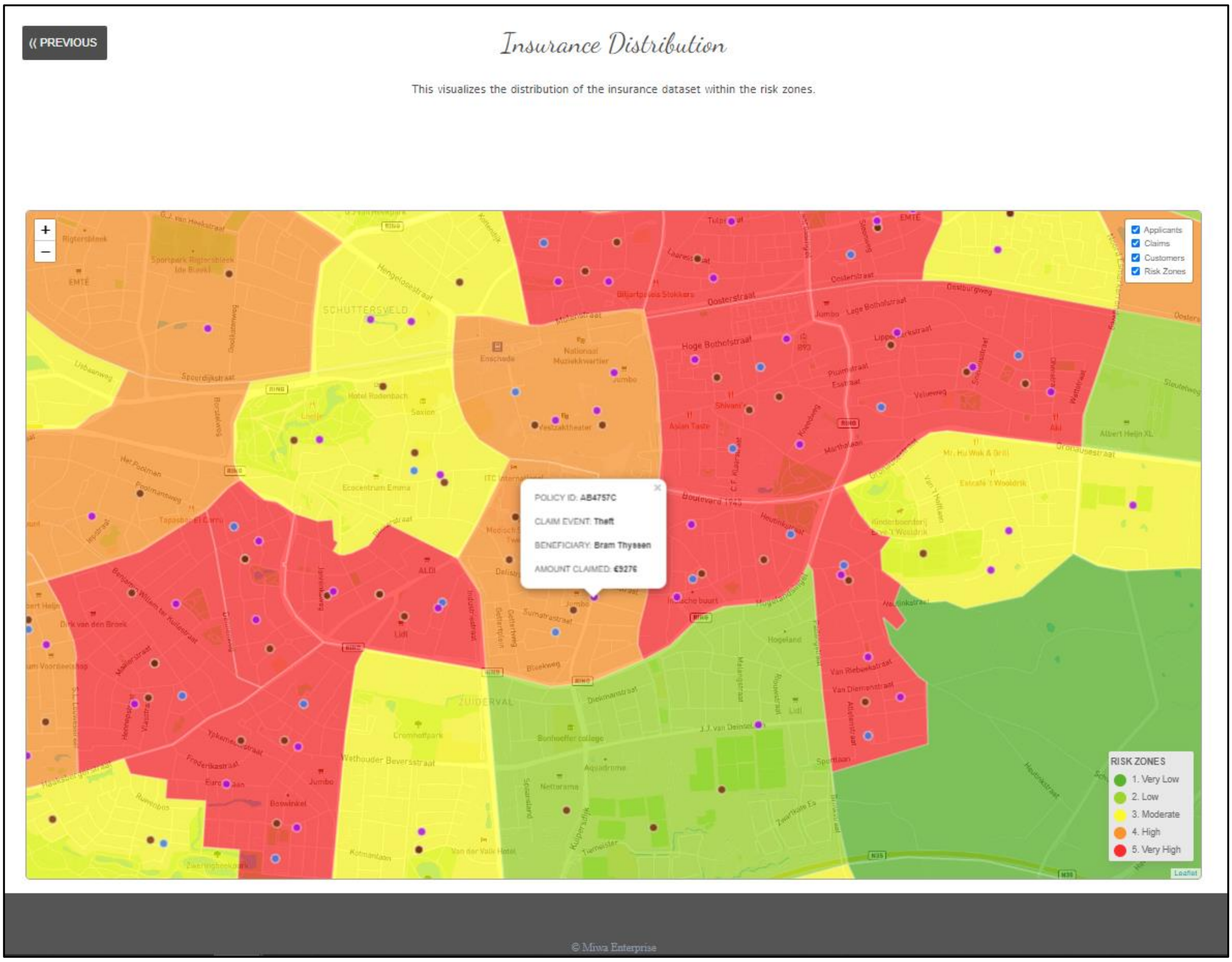

Figure 38: Snapshot of Insurance Data Distribution Within the Risk Zones Web map.

The results from the LI-enabled insurance enterprise system, when used in addition to other insurance tools, facilitates more accurate decisions regarding claims management and premium estimation, as aforementioned in section 3.2. The use of GI tools for making decisions especially when it comes to spotting or detecting insurance fraud, like automobile insurance fraud contributes to a more significant percentage of the insurance costs which affects the estimation and distribution of premium in the long run. Here, the use of the LI-enabled system for insurance BP increases the lead over the competition between insurance companies as currently, the ability to reduce costs and still maintain optimal customer satisfaction increases or creates a competitive edge for the insurance company (Panian, 2012). For the duration of running the system over a couple of years, there might be some changes in the influence of each criterion used for the generation of the risk map, leading to a probable change in weights assigned via the updates obtained from the system.

6. CONCLUSION

6.1. Conclusion

Based on the studies and research carried out it was observed that the geographical zones (i.e. the location) of the insurers influenced the number of claims submitted since the riskier the zone, the higher the likelihood of filing claims due to the occurrence of more claim events. With the integration of LI into the insurance BP especially in the determination of the premium payable by potential policyholders and claims management, decisions were made with improved and optimized insights.

Generally, with the adoption of the Bonus-Malus System (BMS) which is a system that modifies the premium paid by customers based on their claim record, the satisfaction and awareness of consequences of actions taken by the insurers are ensured. With the achievement of the research objectives, the insurance organisation has an improved and optimised way of managing claims as well as estimate these premiums for the adoption of the BMS. For example, the provision of secondary discount to policyholders with less risky behaviours and also those with no claims submitted in previous years, likewise an increase of the premium paid by policyholders who have submitted more claims than initially estimated during the policy year.

Furthermore, the implementation of this research provides introductory guides to the development of LI-enabled ERP system for insurance BP and also offers insights to the benefit it portends. One of the benefits being the introduction of transparency into the premium calculation process, as the users are able to view the risk zones and estimate their premium payable before the completion of the application.

6.2. Answers to RQ

Conducting this research on the integration of LI into the ERP system for insurance business processes using the ERPNext creates for the achievements of the research objectives in section 1.4 and provided answers to the research question outlined in section 1.4.2.

Research Questions – Sub-objective 1

Which insurance business process is the LI factor more relevant to? Who are the stakeholders involved in the insurance business process?

The vital business processes which the LI factor can be integrated within the insurance organisation are the estimation and calculation of premiums for onboarding new policyholders (i.e. applicants) and the management of claims submitted by existing policyholders (i.e. customers). The stakeholders involved in the insurance BP are those responsible for making decisions about the applicants and customers who have been aforementioned in section 3.3 with detailed tasks and responsibilities shown in Table 1.

Research Questions – Sub-objective 2

What are the possible methods to connect LI with insurance business process? What new benefits are created from the already existing business process, and how can these benefits be measured? How can the optimization be measured using the selected integration method?

Amongst the several methods used for connecting LI with insurance BP, the method selected for the execution of this research involved the development of an LI-enabled ERP system using ERPNext which aided the automation as well as improved the optimization of insurance BP like the estimation of premium for applicants and the management of claims for policyholders. During the integration of LI with the insurance BP in the ERPNext system, the optimization was measured by undergoing several checks during the application and claims process just as seen in Figure 9 and Figure 10. These checks serve as the assessment and validation of documents submitted during the policy application or claims request. With the use of this integrated system, investigations can easily be carried out during the notification of a fraudulent application or claim submissions.

Research Questions – Sub-objective 3

How does LI affect the workflow of the insurance industry? What are the measurable variables, and what results are derived from them? Which Critical Success Factors (CSFs) must be accounted for to successfully integrate ES with the insurance business workflows?

With the integration of LI into the insurance BP workflow, the achievements of a harmonized database (i.e. the ERPNext system), the automated validation and assessment of applications plus claims were fulfilled. Figure 11 shows the in-depth execution of the assessment of claims and gives the framework involved in the automated claims process workflows. The delineation of risk zones and routes within the insurance zones combined with the insurance datasets visualizes claims expectations as well as the estimated premiums for applicants on viewing their locations within the zones. The execution of successful integration of ES with the insurance business workflows was assessed using critical success factors such as ensuring the completeness, operationality decomposability and non-redundancy of all the datasets, criteria and methods utilized as discussed in section 2.5.

6.3. Limitations of the Study

Due to the nature of the insurance business and privacy concerns, real insurance data was not used for the execution of this research, thereby limiting its evaluation. The applicant information used for the car insurance policy is assumed to be the owners of the vehicle; hence the information provided for the application is owned by the car owners (i.e. policyholders and applicants) and not necessarily the driver of the car. For example, the case where the car owners have designated drivers was not considered for this research. More time was spent in developing an insurance module within the ERPNext for ingesting the insurance datasets hence reducing the time spent in improving the web application for usability testing by insurance companies. The web application created for the optimization of the insurance business process required additional loading time during analysis and processing, especially in visualizing polygonal features like the risk zones. Since there was limited prior knowledge on the possible occurrences of claim events, the claim types (i.e. fire, theft and accident) were aggregated per risk zone which led to the use of a harmonized and generalized data result for the risk analysis.

6.4. Recommendation

For further research efforts, the development of the integration of LI in ERPNext for insurance business processes can be executed with an insurance company making use of real insurance data in order to assess and evaluate the full procedure involved in the usability testing of the web application developed for improving premium calculation and for claims management. With more data, the risk zones can be better delineated, with multiple risk zones per claim type. The compatibility of ERPNext with Windows could be improved on.

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APPENDIX

Annexe A – Zonal Data (Neighbourhood data)

The main attributes in the **CBS_Buurt** data as compiled by the **Dutch Central Bureau for Statistics (CBS)** are listed as the followings:

Attribute	Description
GM_NAAM	Municipality name
GM_CODE	Municipality code
BU_CODE	Neighbourhood code
BU_NAAM	Neighbourhood name
POSTCODE	Most common zip code
AANT_INW	Number of inhabitants [absolute]
AANT_MAN	Number of men [absolute]
AANT_VROUW	Number of women [absolute]
P_00_14_JR	Percentage of inhabitants who are between 0 and 14 years old (%)
P_15_24_JR	Percentage of inhabitants who are between 15 and 24 years old (%)
P_25_44_JR	Percentage of inhabitants who are between 25 and 44 years old (%)
P_45_64_JR	Percentage of inhabitants who are between 45 and 64 years old (%)
P_65_EO_JR	Percentage of inhabitants who are 65 and older (%)

Remarks:

The explanation for the missing **Values** in numerical fields:

- Data missing.: 99 999 999
- Null: - -99 999 998
- Private: x-99 999 997

Annexe B – Building Information

The main attributes in the **building data complied during the core module course under the "Enschede database" created** are listed as the followings:

Attribute	Description
BuildType	Building Type ID
Year	Construction year of the building
Stadsdeelcode	Stadsdeel code associated with each building
Zones	Zones associated with each building
Type	Building type associated with the Type ID
Building_Class	Building category

Remarks:

The codes used for the building type are described in the table below.

Type ID	Building Type	Building Category
1	House	Residential
2	Housing Unit	Residential
3	Other Type of Living Space	Residential
4	Company or Office	Commercial
5	Transformer	Industrial
6	Power Pylon	Industrial
7	Boiler House	Industrial
8	Radio/TV Mast	Industrial
9	Bicycle Shed	Residential
10	Garage Boxes	Residential
11	Cashpoint	Industrial
12	Distribution Box	Industrial
15	Salthouse	Industrial
16	Shed	Residential

Annexe C – Stadsdeel Information (City District)

The main attributes in the **Stadsdelen** information used during the analysis of this research work are listed as the followings:

Stadsdeel Code	Description
N	North
O	East
W	West
Z	South
C	Central

Annexe D – Risk Zone Information

The main attributes in the **Risk Zones** developed are listed as the followings:

Attribute	Description
NB_Code	Neighbourhood code
Population	Number of inhabitants
Pop_Density	Population density (inhabitants per m^2)
Zone_Length	Length of each zone (m)
Zone_Area	Area of each zone (m^2)
Stadsdelen	City districts
Road_Length	Length of the road (m)
Building_Area	Area of the building (m^2)
Urbanization_Level	Urbanization level
Claim_Incident	Claim events normalized with zonal area
Theft_Recorded	Number of theft occurrence recorded
Accident_Recorded	Number of accident occurrence recorded
Fire_Recorded	Number of fire incidents recorded
Claim_Events	Sum of all incidence occurrence
Incident_Reclassify	Reclassification for the total number of claim incidence
Urbanization_Reclassify	Reclassification for the urbanization level
PopClass_Reclassify	Reclassification for the population density
Reclassifcation	Sum of all reclassification for defining the risk level
Risk_Zones	Risk level for each zone based on the reclassification

Annexe E – JSON file for the Risk Zones Generated

```
var map = L.map('mapid').setView([52.2152, 6.889], 12);

// default leaflet with mapbox tile map load
L.tileLayer('https://api.mapbox.com/styles/v1/{id}/tiles/{z}/{x}/{y}?access_token={accessToken}', {
    attribution: 'Map data &copy; <a href="https://www.openstreetmap.org/">OpenStreetMap</a> contributors, <a
href="https://creativecommons.org/licenses/by-sa/2.0/">CC-BY-SA</a>, Imagery © <a
href="https://www.mapbox.com/">Mapbox</a>',
    zoom: 12,
    id: 'mapbox/streets-v11',
    tileSize: 512,
    zoomOffset: -1,
    accessToken: 'pk.eyJ1IjoibWFwYm94IiwiYSI6ImNpejY4NXVycTA2emYycXBndHRqcmZ3N3gifQ.rJcFIG214AriISLbB6B5aw',
    attribution: '',

}).addTo(map);

// group layers
var zones = L.layerGroup().addTo(map);



//=========== ZONES

function style(feature) {
    return {
        fillColor: riskColour(feature.properties.Risk_Zones),
        weight: 0.5,
        opacity: 1,
        color: "white",
        dashArray: "0",
        fillOpacity: 0.6
    };
}

function riskColour(i) {
    return i == "Very Low" ? "#38a800" :
        i == "Low" ? "#8bd100" :
        i == "Moderate" ? "#ffff00" :
        i == "High" ? "#ff8000" :
        i == "Very High" ? "#ff0000" :
        "#c77f7f";
}

$.getJSON("data/Zones.json", function(data) {

    for (i in data.data) {
        var jsonZones = JSON.parse(data.data[i].geozones);


        L.geoJSON(jsonZones, {
            onEachFeature: function onEachFeature(feature, layer) {

                // console.log(feature);

                var popupContent = "<p>ZONE: <b>" +
                    feature.properties.BU_NAAM +
                    "</b></p><p>POPULATION(2016): <b>" +
                    feature.properties.AANT_INW +
                    "</b></p><p>CLAIM INCIDENCE: <b>" +
                    feature.properties.Claim_Even +
                    "</b></p><p>DRIVABLE AGE(15-24)%: <b>" +
                    feature.properties.P_15_24_JR +
                    "</b></p><p>DRIVABLE AGE(25-44)%: <b>" +
                    feature.properties.P_25_44_JR +
                    "</b></p><p>DRIVABLE AGE(45-64)%: <b>" +
                    feature.properties.P_45_64_JR +
                    "</b></p><p>DRIVABLE AGE(65-EO)%: <b>" +
                    feature.properties.P_65_EO_JR +
                    "</b></p><p>RISK CATEGORY: <b>" +
                    feature.properties.Risk_Zones +
                    "</b></p>";
```

```
                if (feature.properties && feature.properties.popupContent) {
                    popupContent += feature.properties.popupContent;
                }


                layer.bindPopup(popupContent);
            },
            style: style

        }).addTo(zones);


    }


});



// Legend layers control
var overlays = {
    "Risk Zones": zones,
}

var layerControl = L.control.layers(null, overlays, { collapsed: false }).addTo(map);

// set legend position on control
var legend = L.control({ position: "bottomright" });


legend.onAdd = function(map) {
    var legendBox = L.DomUtil.create("div", "info legend"),
        categories = [
            "Very Low",
            "Low",
            "Moderate",
            "High",
            "Very High"
        ],

        labels = [
            "1. Very Low",
            "2. Low",
            "3. Moderate",
            "4. High",
            "5. Very High"
        ];

    // loop through our density intervals and generate a label with a colored square for each interval
    for (var i = 0; i < categories.length; i++) {
        legendBox.innerHTML +=
            `<i style="background: ${riskColour(categories[i])} "></i> ${labels[i]} <br>`;
    }

    return legendBox;
};

legend.addTo(map);
```

Annexe F – Style Used for Creating the Insurance Web Application

```
html {
    height: 100%;
    background-color: white;
}

body {
    height: 100%;
    margin: 0;
    background-color: white;
}

#container {
    height: 15%;
    color: #4e4e4e;
}

#container>h2 {
    font-family: 'Dancing Script', cursive;
    font-size: 40px;
    font-weight: 200;
    text-align: center;
    padding-left: 20%;
    padding-right: 20%;
}

#container>p {
    font-size: 17px;
    text-align: center;
    padding-left: 20%;
    padding-right: 20%;
    font-family: 'Istok Web', sans-serif;
}

#back {
    padding: 15px;
    padding-left: 5px;
    color: whitesmoke;
    background-color: #4e4e4e;
    float: left;
    border: none;
    border-radius: 3px;
    font-size: medium;
    margin-left: 90px;
    cursor: pointer;
}

#mapid {
    height: 70%;
    border: solid #a1a1a1 2px;
    border-radius: 7px;
    margin-left: 5%;
    margin-right: 5%;
    margin-top: 60px;
}
```

```
/* Legend */

.legend {
    margin-bottom: 100px;
    width: 100%;
    line-height: 26px;
    font-size: 13px;
    font-family: 'Average', Helvetica;
    color: #666;
    background-color: #E8E8E8;
    box-shadow: -1px 7px 16px -3px rgba(124, 124, 124, 0.32);
    border-radius: 3px;
    padding: 3px;
}

.legend i {
    width: 18px;
    height: 18px;
    float: left;
    margin-right: 8px;
    margin-left: 5px;
    margin-top: 4px;
    opacity: 0.8;
    border-radius: 50%;
}

#footer {
    height: 15%;
    background-color: #555;
    margin-top: 20px;
    color: #8D99A6;
}

#footer>p {
    text-align: center;
    padding-top: 70px;
}
```

Annexe G – HTML used for generating the Risk Zones Webpage

```
<!DOCTYPE html>
<html lang="en">

<head>
    <meta charset="UTF-8">
    <meta name="viewport" content="width=device-width, initial-scale=1.0">
    <link href="https://fonts.googleapis.com/css2?family=Dancing+Script&display=swap"
rel="stylesheet">
    <link href="https://fonts.googleapis.com/css2?family=Istok+Web&display=swap" rel="stylesheet">
    <link rel="stylesheet" href="https://unpkg.com/leaflet@1.5.1/dist/leaflet.css"
integrity="sha512-
xwE/Az9zrjBIphAcBb3F6JVqxf46+CDLwfLMHloNu6KEQCAWi6HcDUbeOfBIptF7tcCzusKFjFw2yuvEpDL9wQ=="
crossorigin="" />
    <link rel="stylesheet" href="styles/style.css">
    <title>Insurance ERP - MiwaInsurance</title>
</head>

<body>
    <div id="container">
        <input type="button" id="back" value=" &LeftAngleBracket;&LeftAngleBracket; PREVIOUS"
onclick="history.back(-1)" />
        <h2>Risk Zones</h2>
        <p>
            The risk zones were delineated based on the population and urbanization distribution as
well as the claim incident within the insurance zones. The risk zones range from "very high – very
low" risk level with the use of multicriteria decision analysis
            (MCDA) classification method for the division.
        </p>
        <br>
    </div>
    <div id="mapid"></div>
    <div id="footer">
        <p> &copy; Miwa Enterprise </p>
    </div>

    <script src="https://cdnjs.cloudflare.com/ajax/libs/jquery/3.5.1/jquery.min.js"></script>
    <script src="https://unpkg.com/leaflet@1.5.1/dist/leaflet.js" integrity="sha512-
GfFPMF3RvMeYyc1LWMHtK8EbPv0iNZ8/oTtHPx9/cc2ILxQ+u905qIwdpULaqDkyBKgOaB57QTMg7ztg8Jm2Og=="
crossorigin=""></script>
    <script src="scripts/risk-zones.js"></script>
</body>

</html>
```