Integrated Farmers Management Information System: A Case Study Pfunda Tea Company Factory- Rwanda

Roger Nyiringabo, Janvier Nkundukozera, and Luc Einstein Ngend Ngend

Abstract- The study was carried out to develop a computerized farmer and production's records management information system of Pfunda Tea Company factory, which replaced the manual system that the company was currently using. This was done with an intention of changing the current system, which was prone to errors, slow and no security controls to the Farmer and productions' records. The study aims to design a user interface, provide security to farmer and productions' records and to examine the efficiency of the current system and these were used in developing the computer-based management information system for the Pfunda tea company Factory. The study was conducted through different data collection methods, analyzing the data using waterfall model and a computerized system was developed using Microsoft visual basic 6.0 for data entry and manipulation, integrated with SQL Server 2005 for data storage. The system was designed to store data, forms to help access, manipulate and capture information. It was also designed to generate immediate reports about farmer and production's information. This system has security components in form of username and authentications to help make boundaries in the database to secure information from unauthorized and malicious users. Implementation of the new system was done by parallel conversion. In this case, integration of the old and system was done together so as to help achieve a high-performance system, since comparisons can be made easily and in case the new system fails, the old system can easily be reverted.

Index Terms- Database, Information, Information and Communication Technology, Integrated Farmers, Information System, Management Information system.

1. Introduction

Information system can be defined as a set of organized procedures that when executed, provide information for decision making and control of the organization. Information is some tangible or intangible entity that reduces uncertainty about a state or event. Information systems have become a major function area of business administration [1]. The systems, nowadays, plays a vital role in the e-business and e-commerce operations, enterprise collaboration and management, and strategic success of the business [2]. According to EinDor and Segev (1978), an IS becomes a management information system (MIS) when it is applied to improve management by directors of the organization. This system can increase the performance of the management. MIS is a collection of workers', tools, procedures and software to perform various business tasks at various levels in the organization [3]. Moreover, MIS is one of the important functions of management, which plays an important role in providing information that is required for crucial decision making which directly affects the performance of the organization [4]. Agriculture is an important sector with the majority of the rural population in developing countries depending on it. The sector faces major challenges of enhancing production in a situation of dwindling natural resources necessary for production. The growing demand for agricultural products, however, also offers opportunities for producers to sustain and improve their livelihoods [5]. Information and communication technologies (ICT) play an important role in addressing these challenges and uplifting the livelihoods of the rural poor. This article explores the potential contribution of ICT to the livelihoods of small-scale farmers and the efficiency of the agricultural sector in developing countries [6].

Information and Communication Technology (ICT) is widely becoming a common asset of modern socio-economic life in this new world of globalization. This technology is opening opportunities and new avenues for all. Our country, Rwanda small landlocked country, situated in east-central Africa [7]. It is often called The Land of a Thousand Hills because of the innumerable rolling hills that cover the entire landscape, in Rwanda, 90% of the population is engaged in subsistence agriculture [8]. Information and Communication Technology is a central engine to driving Rwanda's transformation to a knowledge-based economy, and the government is seeking to become a regional leader in ICT [9].

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It has a long way to go to be successful in this area. The use of automated system development, networks systems development and the need to share resources within the country and with outside of the world, is the measure of development in the Rwandan society.

Today, the ICT is developing rapidly in all over the world. Recently, the use of Information and Communication Technology such as electronic mail (email), mobile communication, fax, Decision Support Systems (DSS) and the World Wide Web (WWW) has become widespread. For the betterment of future, as a country whole the agriculture, industry, and services sectors have to couple

with this phenomenon [10]. Information is the lifeblood of organization [2]. It is vital to collect accurate and complete information for all market sectors and industries including agriculture. Information promotes competition and improves market performance.

Automation [11] Computer automation in many environments has cut down on the use of manual labor. Computer systems and software have replaced tasks that were mundane and needed several people to perform. Automation has affected every industry in the world and has increased efficiency in manual labor-related areas. For example, if your business manually filed documents, an audit could show that most documents were lost because of human error.

Given the typical nature of Management Information System (MIS) evolving day after day, there the wide range of activities that must be executed to perform Information and Communication Technology [12]. Information management system can be applied to any system that facilitates storage, management and retrieving of data and information required for some particular application within a computer system. This makes it easier for data to be handled or managed. The aim of this work is to create a computerized system, which will manage the traditional production of Pfunda Tea Company Factory. Over the past years, the use of the computerized system as a mean of database management system has been a mystery and the number of organizations and institutions continue to use Traditional File Processing System (TFPS) [13]. Therefore, there is a need for a transformation from rudimentary versions to renovate computerized system of information and resources. According to Haag Cummings and Dawkins [14], they stated that Management Information System (MIS) provides periodic and predetermined reports that summarize information within a database. Thus MISs, are systems that have information processing responsibilities that include creating information through analytical processing and conveying information to whoever needs it. MIS deals with the planning for, development, management, and use of information technology tools to help people perform all tasks related to information processing and management.

Pfunda Tea Farmers Company Factory is a Private Company that is located Rwanda, in a company, there is no automated system of managing Company activities such as registering tea farmers their production. So, what they do now, to register the above mentioned, is to keep hard copies using Traditional File Processing System (TFPS) in which there the database of all Tea farmers according to their identification (paper-based system) [15]. Really, those hard copies are not secured properly; moreover, those hard copies consume much space. This work provides how to register all tea farmers' production and avoids time wastage for tea farmers and space management where mentioned hard copies are stored. The Company needs to register tea farmers and their production. The way of registering Tea Farmers and their production in the existing system that this Company uses, meets some difficulties and limitations such as Data Loss and Redundancy, Data Security and Integrity, Searching and Processing time are high, Reports production is difficult and most exposed to errors [16]. These systems vary in size, scope, and capability, from packages that are implemented in relatively small organizations to cover farmer records alone, to Company-wide solutions that aim at covering most aspects of running large organizations with significant local responsibility [17].

Tea farmer records management information system starts from a simple farmer group to a complex open communication channel, which facilitates synchronization to help Company be efficient and effective.

Tea farmer records management information system provides the complete information and management for the Farmers, Dairy Workers, and other staffs members. It provides the Company administration with the information needed for planning, policy making and decision support [18].

This research work is aimed to design and develop software, which is able to manage farmers and their production and ease communication among Company office. The tea farmers' records management information system is a tea farmer's level-data collection system that allows the development concerned with farmers' records to collect and analyze information accurately and comprehensively, to meet standard reporting requirements and to inform policy and programmatic decisions. A farmer record management information system is a software application for Pfunda tea Company Factory to manage tea farmer's data. A farmer record management information system provides capabilities for entering farmer test and other assessment scores,

building farmer schedules, tracking farmer production performance, income status and managing many other farmer related data needs in the Company.

2. METHODS AND DESIGN

2.1. Waterfall model

The waterfall model is the classic model of software engineering. This model is one of the oldest models and is widely used in government projects and in many major companies. Because the model emphasizes planning in the early stages[19], it catches design flaws before they develop. Also, because the model is document and planning intensive, it works well for projects in which quality control is a major concern.

The pure waterfall model consists of several non-overlapping stages, as shown in the following illustration. The model begins with establishing system requirements and software requirements and continues with architectural design, detailed design, coding, testing, and maintenance. The waterfall model serves as a baseline for many other lifecycle models[20]

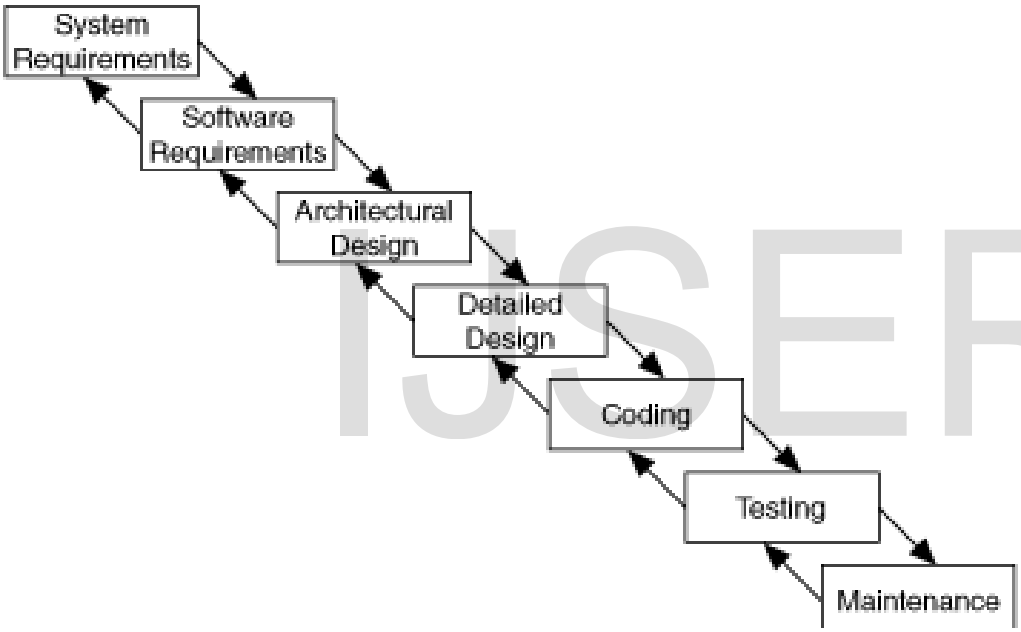


***Figure1**: The diagram structure of Waterfall model*

The following list details the steps for using the waterfall model:

System requirements: Establishes the components for building the system, including the hardware requirements, software tools, and other necessary components.

Software requirements: Establishes the expectations for software functionality and identifies which system requirements the software effects. Requirements analysis includes determining interaction needed with other applications and databases, performance requirements, user interface requirements, and so on.

Architectural design: Determines the software framework of a system to meet the specified requirements. The design defines the major components and the interaction of those components, but the design does not define the structure of each component. You also determine the external interfaces and tools to use in the project.

Detailed design: Examines the software components defined in the architectural design stage and produces a specification for how each component is implemented.

Coding: Implements the detailed design specification.

Testing: Determines whether the software meets the specified requirements and finds any errors present in the code.

Maintenance: Addresses problems and enhancement requests after the software releases.

In some organizations, a change control board maintains the quality of the product by reviewing each change made in the maintenance stage. Consider applying the full waterfall development cycle model when correcting problems or implementing these enhancement requests.[21]

2.2. Technique of data collection

These data collection techniques helped to find out what famers and beneficiaries of Pfunda Tea Company Factory think about current used Tea Production Management Information system and find out the requirement for improving the current system. Techniques is including: **(i) Interview** it involves oral questioning of respondents either individually or in-group. **(ii) Observation**, it involves selecting, watching and recording behavior (Living being, objects and phenomena)[22].
Participant observation: With this technique, the observer takes part in the situation in which he/she is observing this technique gives more detailed and context of related information and permits collection of information on facts not mentioned in an interview. **(iii) Questionnaire**: It almost like interview, but the only difference is that the Designer does not have a meeting with employees. We prepare questionnaire before and submits it to the Farmers who fill it. We collect it later after being filled[23].

2.3. Models of Merise

A model is a subjective and pertinent representation of the reality. It is not the reality but it describes the reality. It is easier to refer on a model than to refer on the reality because the model represents just essential aspects of the reality and ignores the useless aspects.[24]

MERISE has three levels of conception:
(i). The conceptual level, (ii) The logical or organizational level (iii) The physical or operational level
Each level has a model of data and a model of processes as shown below on the table
The following table easily shows the models:

Levels	Data	Process
Conceptual	Conceptual Model of Processes **CMD**	Conceptual Model of Processes **CMP**
Logical or Organizational	Logical Model of Data **LMD**	Organizational Model of Processes **OMP**
Physical or Operational	Physical Model of Data **PMD**	Operational Model of Processes **OPMP**

Table 1: *The models*

2.4. Data Flow Diagram (DFD)

Is a graphical representation of the "flow" of data through an information system, modeling its process aspects. Often, they are a preliminary step used to create an overview of the system, which can later be elaborated. DFDs can also be used for the visualization of data processing (structured design).

A DFD shows what kinds of information will be input to an output from the system, where the data will come from and go to, and where the data will be stored. It does not show information about the timing of processes, or information about whether processes will operate in sequence or in parallel.[25]

2.4.1 Logical Model of Data (LMD) Representation

AGRONOMISTS (AgroID, AgroFirstName, AgroLastName, AgroSex, AgroDOB,
AgroAdress, AgroTelephone)
PRODUCTIONS (ProductionID, OwnerFirstName, OwnerLastName, Weight, DateIn, UnitPrice, TotalPrice, AgroID#, BranchID#)
BRANCHES (BranchID, BranchLocation, Branch Phone)
SIGN (ContractID, FarmerID**)**
FARMERS (FarmerID, FarmerFirstName, FarmerLastName, FarmerSex, FarmerDOB, FarmerAddress, FarmerTelephone, FieldSurface)
WAGES (WageID, Date, Location, Description, Amount, Transport, Fertilizer, Harvester, VAT, NetAmount, Wording, FarmerID#)

WORKERS (WorkerID, WorkerFirstName, WorkerLastName, WorkerSex, WorkerDOB, WorkerAddress, WorkerTelephone)
WORK FOR (WorkerID, FarmerID)
CONTRACTS (ContractID, SignDate, SignOut, Category)

2.4.2 PHYSICAL MODEL OF DATA (PMD)

According[26] a physical data model (or database design) is a representation of a data design which takes into account the facilities and constraints of a given database management system.

In the lifecycle of a project, it is typically derived from a logical data model, though it may be reverse-engineered from a given database implementation. A complete physical data model would include all the database artifacts required to create relationships between tables or achieve performance goals, such as indexes, constraint definitions, linking tables, partitioned tables or clusters. The physical data model could usually be used to calculate storage estimates and may include specific storage allocation details for a given database system.[20]

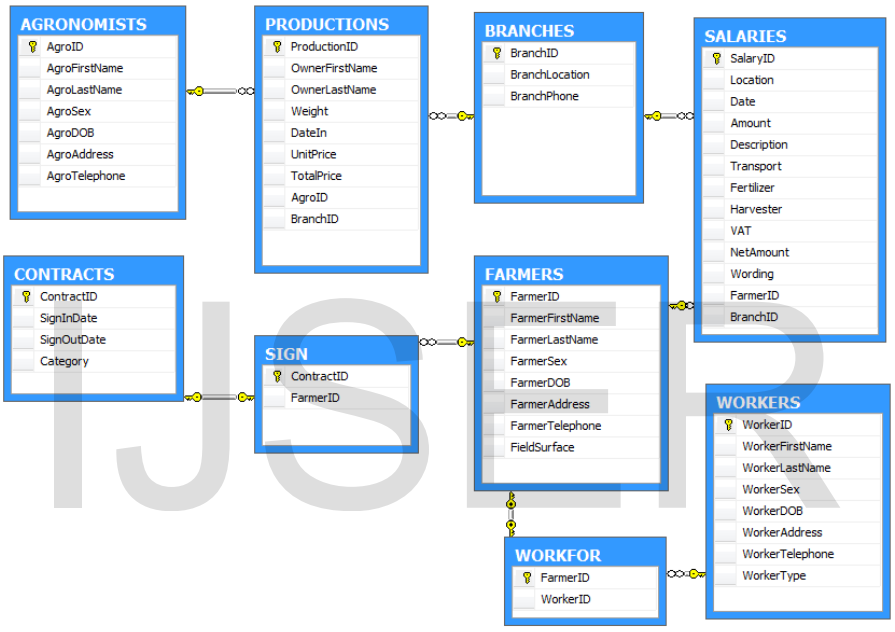


***Figure 2**: PMD representation*

3. RESULTS AND DISCUSSION

In developing Tea Production Management Information System (TPMIS), technologies used in order to achieve its full functionality were:

SQL SERVER 2005

SQL SERVER is a powerful program to create and manage your database it has many built-in features to assist one in constructing and viewing one's information.
SQL (Structured Query Language): is a database computer language designed for managing data in relational database management system (RDMS). Its scope includes data query and update schema creation and modification and data access control. It is most widely used language for relational database.

Visual Basic 6.0

Visual Basic 6.0 is a third event-driven programming language and integrated development environment (IDE) from Microsoft. It was used in designing interfaces (forms) and connecting forms to the database using DAO (3.6), one of its methods used to link forms to the database.

CRYSTAL REPORTS 8.5

Crystal Reports is designed to work with your database to help you analyze and interpret important information. Crystal Reports makes it easy to create simple reports, and, it has the comprehensive tools you need to produce complex or specialized reports.

TESTS

In order to prove the reliability of Tea Production Management Information System (TPMIS), some tests were conducted, some of those tests include:

Access and security Test: This is conducted to prove if the required security system on data used and stored using TPMIS have been achieved, the test was done by entering an unknown username and password to check if the system will grant access and the system proved more secured and capable of withstanding to hackers.

Effectiveness Test: this is to ensure that the system will produce intended results, the test was conducted on different forms and specifically on reports, by for example trying to save data with incoherent details or trying to query an unknown data, the system will reject the request and apart from that this system has produced 100% of the expected functionalities.

User-Friendly Test: A system would not be user-friendly if it was not designed to easily operate by non-specialist's users; this is why a test has been conducted to prove it. The test was done by asking some amateur user to see if they can at least understand the basic icons and commands of TPMIS and most of them proved to find the system easy to use.

Portability Test: This was done to prove if the system could run on any other computer that running any version of operating system. After conducting this test, TPMIS proved to be more portable.

3.2. SOME INTERFACES

Good software should be attractive; the attractiveness of Tea Production Management Information System (TPMIS) is seen through its different forms and Reports. Here are some of the interfaces of Tea Production Management Information System (TPMIS) of Pfunda tea Farmers Company.

Login interface

The login interface is the interface that enables the user to enter into the system by entering its username and password. This is for security purpose to prevent everybody to use the system without permission.

This Screen is used for Authentication purpose in order to know if the access to software is given to the authorized user. The user has to fill up his/her username and password for authorization. The form has one button to Connect and Close.

Finally, he/she should click on the connect button after filling username and the password or click on close to ignore command. When the authentication process has completely done then, the main menu screen will appear now user get access to the functionality of the project.

Figure3: *Login interface*

Progression Form

This form shows the user how much time counted in percentages can wait for the loading application for starting, in order to not bored of waiting.

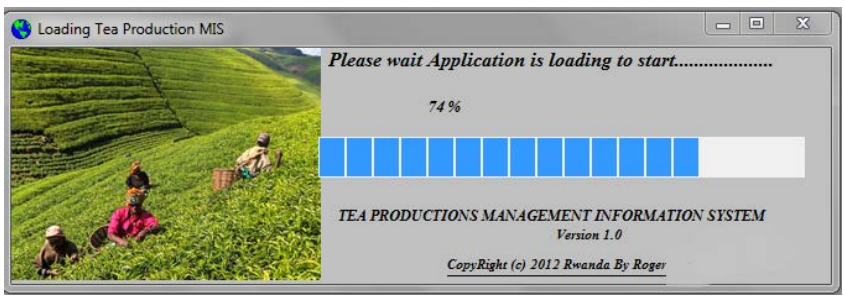


Figure4: *Progression Form*

Main Menu Form.

After Progression Form is successful, the user gets access to the main menu of an administrator. This main menu form contains some principal menus which also contain submenus which gives access to different operations within the project.

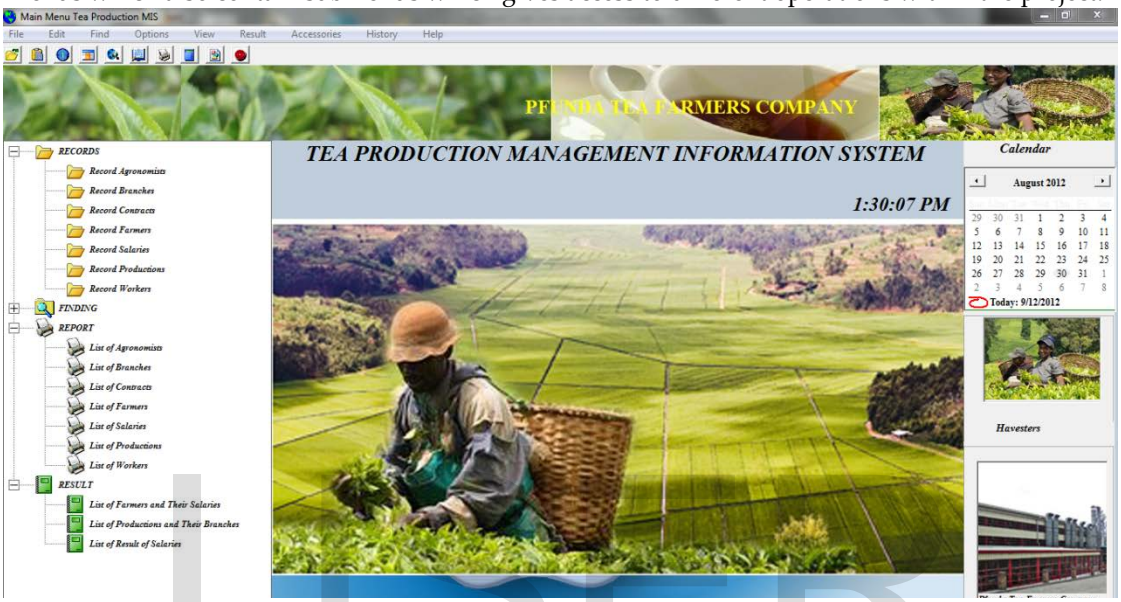


Figure5*: Main Menu Form.*

Production Form

Below is the interface used to register the new productions and its details, also allows updating some of the production details.

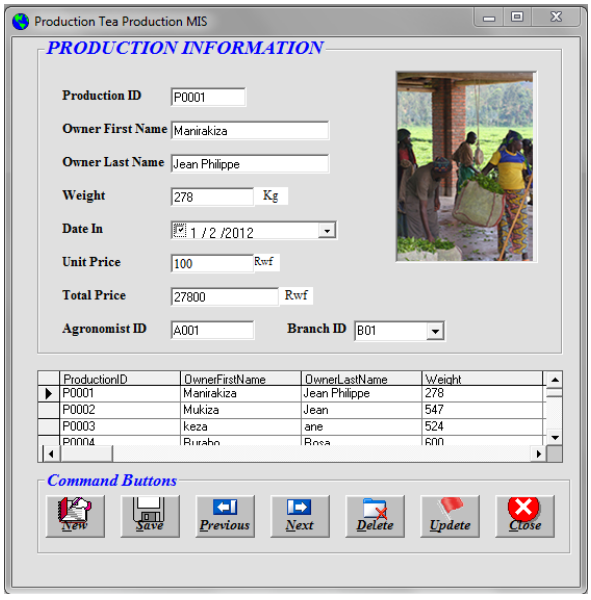


Figure6*: Production Form*

Find Production Form

This form allows to find or search information about a particular Production. The user fills in the field identification of the Production and then click on find button; or he/she can find the details of the Production by name, then click on find button, also this form allows him /her to print the whole details.

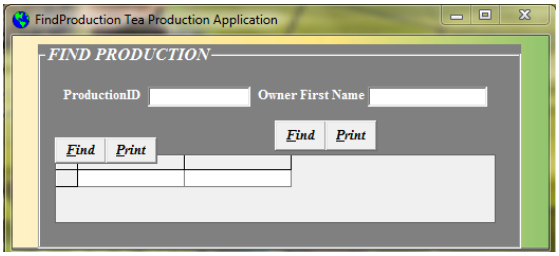
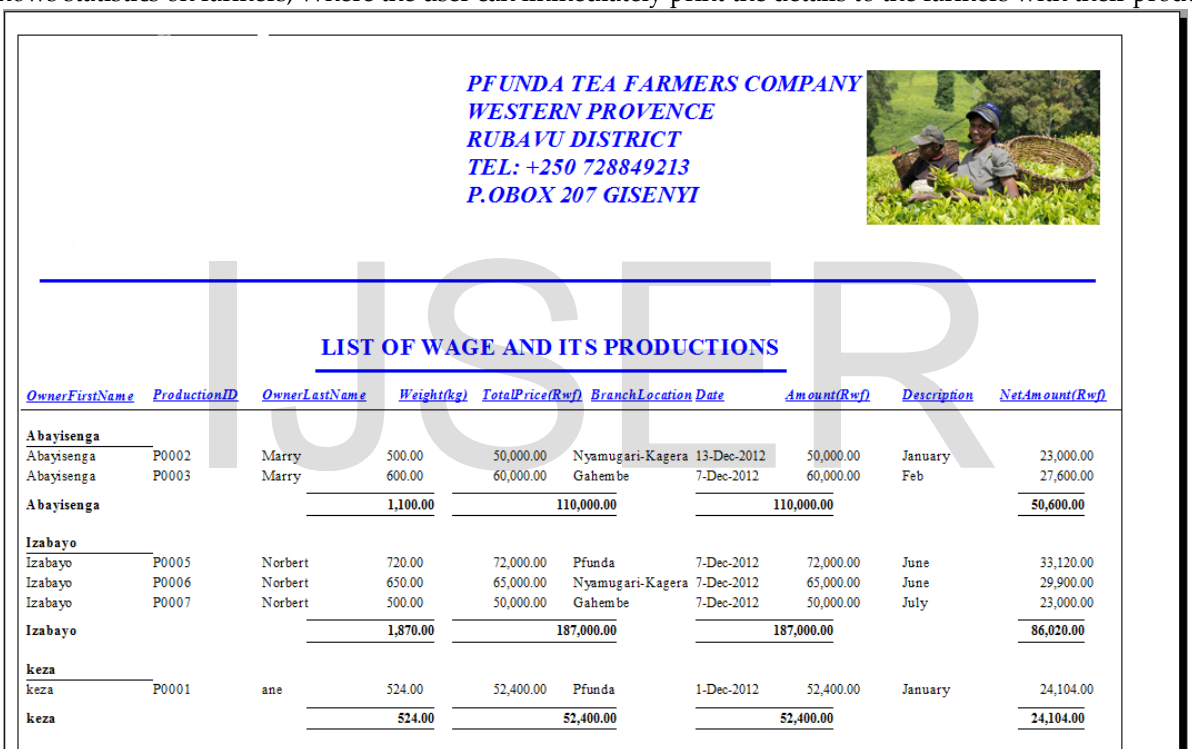


Figure7: Find production

Form concerning Report

This form shows statistics on farmers, Where the user can immediately print the details to the farmers with their productions.



PFUNDA TEA FARMERS COMPANY
WESTERN PROVENCE
RUBAVU DISTRICT
TEL: +250 728849213
P.OBOX 207 GISENYI

LIST OF WAGE AND ITS PRODUCTIONS

OwnerFirstName	ProductionID	OwnerLastName	Weight(kg)	TotalPrice(Rwf)	BranchLocation	Date	Amount(Rwf)	Description	NetAmount(Rwf)
Abayisenga									
Abayisenga	P0002	Marry	500.00	50,000.00	Nyamugari-Kagera	13-Dec-2012	50,000.00	January	23,000.00
Abayisenga	P0003	Marry	600.00	60,000.00	Gahembe	7-Dec-2012	60,000.00	Feb	27,600.00
Abayisenga			**1,100.00**	**110,000.00**			**110,000.00**		**50,600.00**
Izabayo									
Izabayo	P0005	Norbert	720.00	72,000.00	Pfunda	7-Dec-2012	72,000.00	June	33,120.00
Izabayo	P0006	Norbert	650.00	65,000.00	Nyamugari-Kagera	7-Dec-2012	65,000.00	June	29,900.00
Izabayo	P0007	Norbert	500.00	50,000.00	Gahembe	7-Dec-2012	50,000.00	July	23,000.00
Izabayo			**1,870.00**	**187,000.00**			**187,000.00**		**86,020.00**
keza									
keza	P0001	ane	524.00	52,400.00	Pfunda	1-Dec-2012	52,400.00	January	24,104.00
keza			**524.00**	**52,400.00**			**52,400.00**		**24,104.00**

Figure8: *Report Form*

The effectiveness of Tea Production Management Information System (TPMIS) is to provide results required by users as described in chapter 1, Tea Production Management Information System (TPMIS) is needed by Pfunda Tea Company Factory(PTCF) to manage their Farmers 'details easily, reliably, securely and efficiently. TPMIS can generate information about Farmers, Productions, Branches, and wage involved in one report, which will help a farmer to monitor its production of that report. The system can also provide a list of Production statistics in each Branch. Concerning the expected results and the results founded, the system is giving what is expected to give.

4. CONCLUSIONS

The objective of our research project was to develop computerized system that can enable the management of farmer and production's registration at PTCF. This system can resolve many problems related to the manual data registration and storage such as loss of some files, slow data retrieval, lack of safety and inadequate communication and generation of reports.

In fact, the administrator has full ability to control and keep safely all information about the farmers and their productions and this offers security enhancement of the data kept by the factory.
In general, it is found that development of such computerized system provides attractive features of data protection, data integrity, reduced inconsistency, standardization and sharing of data.
The computerized system should be used since it can handle farmers and productions' records more effectively because it provides security to Farmers and productions' records, speeds up data processing, offers a high level of interactivity, therefore, easing quick decision making for the Pfunda tea farmers company. The new system has made easy to retrieve, store, control, update and get rid of unwanted information in the database.

ACKNOWLEDGEMENT

We extend our appreciation to the staff of Pfunda Tea Company Factory for assisting us in collecting data and our respective universities to facilitate our research.

Author Contributions

Roger Nyiringabo conceived of the presented idea, developed the theory and performed the computations. Janvier Nkundukozera
and Luc Einstein Ngend Ngend verified the analytical methods and helped to illustrate the findings of this work. All authors discussed the results and contributed to the final manuscript.

Conflicts of Interest

The authors declare no conflict of interest

REFERENCES

[1] I. Systems and A. Process, *Information Systems Certified Information Systems Auditor Course*. 2014.
[2] G. D. YADETA, "ROLE OF MANAGEMENT INFORMATION SYSTEM IN BUSINESS ORGANIZATIONS," p. 4.
[3] L. J. Quackenbush, "A Review of Techniques for Extracting Linear Features from Imagery," *Photogramm. Eng. Remote Sensing*, vol. 70, no. 12, pp. 1383–1392, 2004.
[4] M. Van Hoek, J. Zhou, L. Jia, J. Lu, C. Zheng, and G. Hu, "A web-based platform for global drought monitoring and early warning based on time series analysis of multiple variables and indicators," no. Cdi.
[5] M. Costa Freitas, A. Xavier, and R. Fragoso, "Integration of Fire Risk in a Sustainable Forest Management Model," *Forests*, vol. 8, no. 8, p. 270, 2017.
[6] J. Stienen, W. Bruinsma, and F. Neuman, "How ICT can make a difference in agricultural livelihoods," p. 3, 2007.
[7] A. S. A. Mark S. Nixon, *Feature Extraction & Image Processing for Computer Vision*. 2012.
[8] A. IPAR, "RWANDAN AGRICULTURE SECTOR SITUATIONAL ANALYSIS."
[9] "Key Highlights Rwanda Country," Rwanda, 2017.
[10] H. Jayathilake, B. Jayaweera, and E. Waidyasekera, "ICT Adoption and Its' Implications for Agriculture in Sri Lanka," *J. Food Agric.*, vol. 1, no. 2, p. 10, Apr. 2010.
[11] S. Africa, "A Perspective on Sea Level Rise and Coastal Storm Surge from Southern and Eastern Africa: A Case Study Near Durban, South Africa," pp. 237–259, 2012.
[12] G. Nduwayezu and G. Nduwayezu, "MODELING URBAN GROWTH IN KIGALI CITY RWANDA MODELING URBAN GROWTH IN KIGALI CITY RWANDA," 2015.
[13] Y. Hategekimana, L. Yu, Y. Nie, J. Zhu, F. Liu, and F. Guo, "Integration of multi-parametric fuzzy analytic hierarchy process and GIS along the UNESCO World Heritage: a flood hazard index, Mombasa County, Kenya," *Nat. Hazards*, 2018.
[14] M. C. Stephen Haag and James Dawkins, *MANAGEMENT INFORMATION SYSTEMS*, 12th ed. McGraw-Hill, Inc. New York, NY, USA, 2000.
[15] F. Karamage, C. Zhang, F. Ndayisaba, H. Shao, and A. Kayiranga, "Extent of Cropland and Related Soil Erosion Risk in Rwanda."
[16] F. Denton, T. J. Wilbanks, A. C. Abeysinghe, I. Burton, Q. Gao, M. C. Lemos, T. Masui, K. L. O'Brien, and K. Warner, "Climate-Resilient Pathways: Adaptation, Mitigation, and Sustainable Development," *Clim. Chang. 2014 Impacts, Adapt. Vulnerability. Part A Glob. Sect. Asp. Contrib. Work. Gr. II to Fifth Assess. Rep. Intergov. Panel Clim. Chang.*, pp. 1101–1131, 2014.
[17] H. Yu, W. Yang, G. Hua, H. Ru, and P. Huang, "Change Detection Using High Resolution Remote Sensing Images Based

on Active Learning and Markov Random Fields," *Remote Sens.*, vol. 9, no. 12, p. 1233, 2017.

[18] K. J. H. Williams and J. Schirmer, "Understanding the relationship between social change and its impacts: The experience of rural land use change in south-eastern Australia," *J. Rural Stud.*, vol. 28, no. 4, pp. 538–548, 2012.

[19] C. Technology, "Cognitive Technology Journal," pp. 166–191, 2009.

[20] H. F. Tipton, *Information Security Management*, 4th Editio. .

[21] C. Severance, "Python for Informatics Exploring Information," *Computer (Long. Beach. Calif).*, pp. 1–236, 2010.

[22] X. Li and A. G.-O. Yeh, "Neural-network-based cellular automata for simulating multiple land use changes using GIS," *Int. J. Geogr. Inf. Sci.*, vol. 16, no. 4, pp. 323–343, 2002.

[23] D. Araya-muñoz, M. J. Metzger, N. Stuart, A. M. W. Wilson, and D. Carvajal, "Science of the Total Environment A spatial fuzzy logic approach to urban multi-hazard impact assessment in Concepción , Chile," *Sci. Total Environ.*, vol. 576, pp. 508–519, 2017.

[24] M. Weinmann and M. Weinmann, "Geospatial Computer Vision Based on Multi-Modal Data—How Valuable Is Shape Information for the Extraction of Semantic Information?," *Remote Sens.*, vol. 10, no. 1, p. 2, 2017.

[25] C. V. Analysis, "Change Vector Analysis (CVA) Change Detection : Methods."

[26] ISACA, "Isaca," *Glossary*, pp. 1–103, 2015.