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Chi-Hung Chi
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Leo W. Santoso (Eds.)

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Intelligence in the Era of Big Data

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Preface

This proceedings volume contains papers presented at the fourth International Conference on Soft Computing, Intelligent System and Information Technology (the 4th ICSIIT) held in Bali, Indonesia, during March 11–14, 2015. The main theme of this international conference is "Intelligence in the Era of Big Data," and it was organized and hosted by Informatics Engineering Department, Petra Christian University, Surabaya, Indonesia.

The Program Committee received 92 submissions for the conference from across Indonesia and around the world. After peer-review process by at least two reviewers per paper, 53 papers were accepted and included in the proceedings. The papers were divided into 14 groups: fuzzy logic and control system, genetic algorithm and heuristic approaches, artificial intelligence and machine learning, similarity-based models, classification and clustering techniques, intelligent data processing, feature extraction, image recognition, visualization technique, intelligent network, cloud and parallel computing, strategic planning, intelligent applications, and intelligent systems for enterprise government and society.

We would like to thank all Program Committee members for their effort in providing high-quality reviews in a timely manner. We thank all the authors of submitted papers and the authors of selected papers for their collaboration in preparation of the final copy.

Compared to the previous ICSIIT conferences, the number of participants at the 4th ICSIIT 2015 is not only higher, but also the research papers presented at the conference are improved both in quantity and quality. On behalf of the Organizing Committee, once again, we would like to thank all the participants of this conference, who contributed enormously to the success of the conference.

We hope all of you enjoy reading this volume and that you will find it inspiring and stimulating for your research and future work.

February 2015

Rolly Intan
Chi-Hung Chi
Henry N. Palit
Leo W. Santoso

Organization

The International Conference on Soft Computing, Intelligent System and Information Technology (ICSIIT) 2015 (http://icsiit.petra.ac.id) took place in Bali, Indonesia, during March 11–14, 2015, hosted by Informatics Department, Petra Christian University.

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Keynote and Invited Papers

Data Mining Model for Road Accident Prediction in Developing Countries

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Abstract. Human loss due to road traffic accident (RTA) in developing countries is a big challenge. It becomes more serious in those developing countries where road conditions are not good and due to several reasons government is not able to maintain roads on regular basis. Additionally, increasing number of vehicles, inefficient driving and environmental conditions are also some of the factors which are responsible for RTA. In this work we present architecture of a data mining model. The proposed model is applied on real data set of RTAs from a developing country. The analysis of data gives several useful results, which can be used for future planning to reduce RTAs in developing countries. This paper also presents that how data mining model is better than other models.

Keywords: Data mining, road accident, vehicles, clusters, traffic road.

Behaviour Informatics: Capturing Value Creation in the Era of Big Data

Chi-Hung Chi

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Abstract. Under the era of Big Data, people have been exploring ways of realizing value from data that are at their fingertips. However, it is found that while collecting data is not difficult, value creation is often a big challenge. This makes the approach of "collecting data first before knowing what to do with them" questionable. In this presentation, we discuss the current challenges of big data analytics and suggest how behaviour analytics on trajectory data can help to realize value creation from Big Data.

1 Background and Challenges

As we move to the fourth paradigm of computing – data intensive scientific discovery, numerous research efforts have been spent in building huge big data repositories. Together with data mining and machine learning research, it is hoped that better and more intelligent decisions can be made in real time.

This movement is accelerated by the advance in at least three areas. The first one is social network, where people share their views and opinions in public. The second one is cloud computing, which is an on-demand infrastructure that facilitates sharing of data, collaboration among multiple parties, and support for on-demand computational and storage infrastructure services at low cost. The third one is the internet-of-things. With the maturity of sensor technologies, trajectory movement of entities (including human and things) can now be monitored in real time at low cost. However, gaining access to big data is only the starting point. There are still open issues that need to be addressed in the value creation process when dealing with big data.

One result of the big data mega trend is the building of huge data repositories around the world. In Australia, the government has been pushing for sharing bureau data through spatial information platforms. It is true that data are collected and can be made available to users, but how to make sense out of these data practically and economically is still a mystery to be explored. Without value creation, the high maintenance cost of these repositories cannot be justified, and the motivation for data providers to update their data inside will also disappear.

In the past few years, sensors and sensing techniques have been advancing rapidly for real time data collection with good enough accuracy. Cost of deploying these technologies is also becoming low enough to make real-time data tracking of human,

animals, and even insects (e.g. honey bees) possible. However, without efficient and effective ways to integrate and transform these trajectory data and their context information into manageable knowledge, these data are actually burdens instead of potentials to their owners.

It is true that there have been numerous research efforts in data mining and machine learning. However, most of them are focused on theoretical algorithmic study, and much less emphasis is put in the incorporation of semantic domain knowledge (in particular, the semantic definition of interdependence among various data sources) into the data mining and pattern discovery processes, and in the use of the behaviour interior dimensions such as loyalty and purchase power of customers to support self service analytics.

Related to the analytics platform, internet-of-things, service and cloud computing techniques are quite mature, and lots of machine learning algorithms are also widely available in both commercial (e.g. MatLib) and open source ("Project R") packages. However, how to put them together in a single service platform and how to compose them together automatically (this is called the vertical service composition) to provide "intelligence-as-a-service" for a given domain are still open for exploration.

2 Real Time Trajectory Data and Its Challenges in Value Creation

In the era of big data, one new important data source for analytics and value creation is the real-time behaviour trajectory data streams of entities (e.g. human) as well as their context dynamics (e.g. environmental such as air quality) that are captured through internet-of-things and sensors (in particular body sensors such as those from Android wears and location position sensors). Its value creation process is both complex and challenging because these data are in general heterogeneous and inter-dependent on each other. Furthermore, the potential number of data sources, each describing one measurement view of the behaviour dynamics of an entity/event, is in theory, infinite.

Traditional data mining and machine learning approaches from computer science often try to explore co-occurrence patterns and inter-relationship among trajectory data. However, this is usually done without making full use of the interdependence defined by their implicit semantic meaning and domain knowledge. Heterogeneity of data adds another level of complication because quantification measures such as distance are not uniformly and consistently defined across different data types. On the other hand, although domain experts have full knowledge on the semantics of data, they are often not as knowledgeable as computer scientists when dealing with the real time computation on trajectory data streams. This result in the first challenge, how to use data mining / machine learning techniques and domain knowledge together to effectively define and discover the inter-relationships among different trajectory data sources and to perform effective behaviour analysis.

As trajectory-driven behaviour analytics is gaining its recognition in different business and industry sectors, the expectation of decision makers also goes beyond what traditional analytics that mainly focus on statistical summaries and association/patterns discovery of transactional/measurable behaviour exterior dimensions often provide. Ultimately, what decision makers want is the deep insight about the behaviour interior

knowledge dimensions of entities, by incorporating domain knowledge into the knowledge discovery processes. As an example, the owner of an online shop wants to know not only the "bestselling products of the week", but also the "loyalty", "purchase power", "experience", and "satisfaction" of customers. This results in the second challenge, how to quantify behaviour interior dimensions from exterior transactional (or physically measured) trajectory data and to discover their inter-relationships and relative importance for effective and efficient behaviour analysis.

3 Research Topics in Behaviour Analytics

To achieve this goal, the following is a list of sample research topics for behaviour analytics:

- Effective and efficient deployment of high resolution location tracking network (using Blue-Tooth LE, WiFi-RFIDs, UWB, and Electromagnetic Field) for entities in both indoor and outdoor environment. This forms the basis for behaviour trajectory data tracking and capturing.
- Semantic enrichment of behaviour trajectory data of entities through aggregation of raw trajectory data with their contextual data dynamics, followed by domain knowledge-driven transformation to form behaviour interior dimensions knowledge. This is the data aggregation, integration, and transformation aspects of behaviour analytics; it incorporates domain knowledge into the behaviour trajectory data to create behaviour interior dimensions knowledge as well as to define the interdependence relationship among them.
- Discovery of interdependence relationship among trajectory-driven behaviour data (exterior) and knowledge streams (interior) using data mining techniques. This addresses the interdependence relationships of trajectory data and knowledge streams from the run-time dynamics aspect.
- Coupling interdependence relationships of behaviour trajectory data and knowledge streams into data mining and pattern discovery processes for deep behaviour understanding and prediction. This gives a much better understanding on why things occur; it also gives potentials for future behaviour prediction.
- Design and implementation of a behaviour analytics service system that serves as a publishing, management and operation platform for: (i) software services, (ii) raw trajectory data services, (iii) semantically annotated behaviour trajectory data services (both individuals and collective), (iv) behaviour knowledge services (both individuals and collective), and (v) infrastructure services. Tools to facilitate composition and orchestration of all these services with QoS assurance using public cloud infrastructure such as Amazon EC2 should be developed. Also, automatic matching of behaviour trajectory data/knowledge services with machine learning/data mining algorithms based on their features should also be supported on this platform.

On the Relation of Probability, Fuzziness, Rough and Evidence Theory

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Abstract. Since the appearance of the first paper on fuzzy sets proposed by Zadeh in 1965, the relationship between probability and fuzziness in the representation of uncertainty has been discussed among many people. The question is whether probability theory itself is sufficient to deal with uncertainty. In this paper the relationship between probability and fuzziness is analyzed by the process of perception to simply understand the relationship between them. It is clear that probability and fuzziness work in different areas of uncertainty. Here, fuzzy event in the presence of probability theory provides *probability of fuzzy event* in which fuzzy event could be regarded as a generalization of crisp event. Moreover, in rough set theory, a rough event is proposed representing two approximate events, namely lower approximate event and upper approximate event. Similarly, in the presence of probability theory, rough event can be extended to be *probability of rough event*. Finally, the paper shows and discusses relation among lower-upper approximate probability (probability of rough events), belief-plausibility measures (evidence theory), classical probability measures, probability of generalized fuzzy-rough events and probability of fuzzy events.

Keywords: Probability, Rough Sets, Fuzzy Sets, Evidence Theory.

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Business Process Maturity at Agricultural Commodities Company

Lily Puspa Dewi[1], Adi Wibowo [1], and Andre Leander [1]

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Abstract. The agricultural commodities company nowadays strive to keep transforming their business processes in accordance with the fast changing demands to survive the intense global competition. In an attempt to provide stakeholder with an insight business process, this paper investigates how to model business processes with Business Process Modelling Notation and assesses the process maturity using Gartner's model. This research is based on an in-depth observation at purchasing and production division of agricultural commodities company. It is found the business process model presents the knowledge from business in existing context. The other findings show the maturity level of the people is on phase 1, the maturity level of IT achieves phase 3, and the maturity level of the other four factors including strategic alignment, culture and leadership, governance and methods have already arrived phase 2. These findings will help company to do big planning for improvement in the future.

Keywords: agricultural company, business model, process maturity

1 Introduction

1.1 Background

Agriculture can be one of the most satisfying and rewarding ways to make a living. From farming and food production to agribusinesses contribute to the health of the population and food security of the country. The agricultural commodities companies nowadays strive to keep transforming their business processes in accordance with the fast changing demands so as to survive the intense global competition. Creating a viable value-added agriculture business involves finding an idea or opportunity in the marketplace and then building a viable business to take advantage of the opportunity. This means improving business process is important to be done continuously in many aspects [1]. Therefore, business process management (BPM) becomes the most popular business and technology management method recently [2]. When company has carried out BPM, they have to know where and how the improvement can be done. Gartner introduce the BPM maturity model to measure the company's maturity phase from many aspects. With Gartner's model, the company will know what phase they are and which factors should be re engineered.

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1.2 Research Goal

This research assesses the agricultural business process and evaluates its maturity using Gartner model. Garner model is used because this model presents information to identify characters of each maturity phase. Gartner model focuses on six factors which are strategy alignment, culture and leadership, people, governance, methods and information technology. These six factors is called six critical success factor. Each factors have different maturity phase.

2. Literature Review

Business process is a group of related task performed to reach a specific business outcome [3]. Business services today have become increasingly active, knowledge-intensive. Therefore, it is quite natural that method to describe the existing business. In this case, the document flow systems are much more flexible and better adapted to the behavior of the business [4].

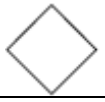
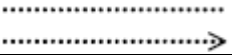
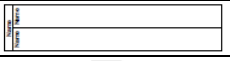
2.1. Business Process Management (BPM)

The concept of BPM is mainly comes from Business Process Reengineering (BPR) [5]. The main focus of BPR is business process and information technology, and its success is built on the good communication and collaboration of information technology and business [6]. With the IT support such as hardware, software tools and network, BPM helps to achieve the optimized and value creation of operational business processes [7]. Other researcher said that BPM is IT-focused which characteristics BPM from the perspective of business process automation [8].

2.2. Business Process Modeling Notation

Business Process (BP) models constitute a graphical representation of processes in an organization. Business Process Model and Notation (BPMN) [9] is a notation for modeling Business Processes, which contributed significantly in Software Engineering when it comes to collaboration between developers, software architects and business analysts. Business Process Modeling Notation (BPMN) is a notation that describes the logical steps in the business process [10]. This notation has been especially designed to coordinate the sequence of processes and messages that flow between participants in different business activity. The notation of BPMN can be seen at Table 1.

Table 1. BPMN modeling elements. (Source: Business Process Modelling Notation, p. 18)

Element	Description	Notation
Event	Event indicate that something is happening during the business process. Events affecting the flow and is usually caused by a trigger or an impact as a result of the event,	
Activity	Activity is a notation that describes their work done. Activity can be atomic (one event) or Sub-Process (set of activities)	
Gateway	Gateway serves as a control in order to split or merge process flow.	
Sequence Flow	Sequence flow is used to display the sequence of activities contained in a process.	
Message Flow	Message flow is used to show the flow of messages between the two participant (entity) the sender and recipient. In BPMN, the existence of two separate Pool indicate a second participant.	
Association	Association used to provide information regarding data object involved	
Pool	Pool describes participant in a process. Usually illustrates B2B situation.	
Lane	Lane is part of the Pool which usually categorize the activity / functional split participant.	
Data Object	Data objects are interpreted as an artifact that has the information.	
Group	Grouping is used to categorize activities possess similarities category.	
Text Annotation	Text Annotation present additional information in the BPMN diagram.	

2.3. Gartner Maturity Model

Based on Gartner maturity model, it has six phases BPM maturity model that involves understanding the six phases of BPM maturity and where the company stands on addressing critical success factors defined in BPM maturity framework [11]. The six phases of BPM maturity can be seen at Fig. 1.

The six phases begin in **Phase 0**: company realizes that some business improvement cannot be done by traditional approaches. The company needs to seek the causes of bad performance. In **Phase 1**, company realizes "process aware" and take some actions to improve the process. In **Phase 2**, company starts to do the business process with IT support to gain better control in internal company. In **Phase 3**, the company build the relationship between internal company and external company (customer and supplier), cross-department cooperation and integration become a habit gradually. In contrast to phase 3, in the **Phase 4**, organization will link strategic goals to process execution directly. Ultimately, in the **Phase 5**, the company will do the agile business structure, that helps to capture new opportunities, gain more profits, knowledge about market demand, resources, competition and partners [11].

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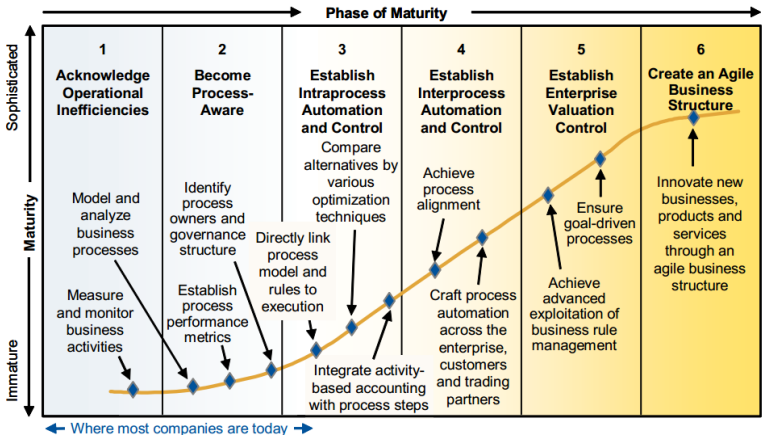

Fig. 1. The six phases of BPM maturity. (Source: Gartner, p. 4)

2.4. Six Critical Success Factors

The important dimension is the organizational factors must be balanced in maturity phases called critical success factors [11]. The six success factors are [11, 12]:

- Strategic alignment: the linkages that connect that connect organizational priorities and enterprise processes in order to achieve its business goals.
- Culture and leadership: culture is the values, beliefs, attitudes and behaviors that presents the company identification and public images. Leadership is crucial roles in supporting process design and facilitating cultural change throughout the company.
- People: The individuals and groups who continually enhance and apply their knowledge and professional skill related company's processes.
- Governance: refer to the transparent accountability, responsibility, decision making and reward processes to guide actions.
- Methods: The approaches and techniques to support consistent process for success of company.
- Information technology: The software, hardware and information management systems that enable and support process activities.

3. Research Methodology

The main methods used is qualitative research. The detailed and specific data can be collected through observing, interviewing and document. This research assesses the BPM maturity level in an agricultural through the critical success factors including strategic alignment, culture and leadership, people, governance, methods and information technology. The data collection is done with the primary data (interviews) and secondary data (documents).

In some qualitative research studies, the data and/or findings are returned to participants in order to obtain their validation. In this research used member

validation or member check. Member check is a procedure largely associated with qualitative research whereby a researcher submits materials relevant to an investigation for checking by the people who were the source of those materials [13].

4. Analysis and Results

4.1. Business Process Modelling

Business in agricultural sector has special business processes. The business process focused in this research is the agricultural company for purchasing and production division.

Purchasing Process. In this case, farmers as the supplier to this company could apply loans for farming capital. Farmers do a contract for selling their agricultural products with the company. This contract contains the number and agricultural products, due date, transportation costs and dealing price. Usually, the contract is made in couple of days before delivery time. On due date, farmers will bring agricultural products to the company warehouse directly, but in some cases the company may take the agricultural products from the boats as a delivery transportation. Furthermore, these agricultural products are weighed and samples taken for quality control such as water content, shell, gems, and rootlets. The quality control result determines the price. The beans' water content is a very important factor and should be 6 to 8%. If the water content is too high, microorganisms will spread and their quality will decrease. This water content determine the quality of the agricultural product, furthermore, it affects to the price.

In some cases, the farmers may entrust their agricultural products to the company for the higher future prices. That means, the agricultural products is already weighed, but the company does not give the dealing prices. The company provides this opportunity only for farmers who have become regulars or carry items with a large amount. The aim is that the seller can get a higher price at a later date when prices rise.

The next steps after weighing products, the warehouse clerk will send the invoice to the finance. Finance will check the quantity and price. If the farmers has a contract, the price will be same as stated the contract. The price also depend in the quantity of products.

Production Process. Agricultural products will be dried to reduce the water content. The beans' water content is a very important factor and should be 6 to 8%. If the water content is too high, microorganisms can infest the beans and their quality will be decreased. This drying process do in two ways, first is roasting whish roaster machine and second is still do in traditional way such as the beans is dried under the sun. The traditional drying process is do because the lack of roaster machine meanwhile the climate support this process. The next step is packaging. The agricultural product will be packed in sack with average weight of 70kg. After that, the sack will be put in the warehouse.

The business process modeling for purchasing is shown at the Fig. 2, and the business process modeling for production can be seen at Fig. 3.

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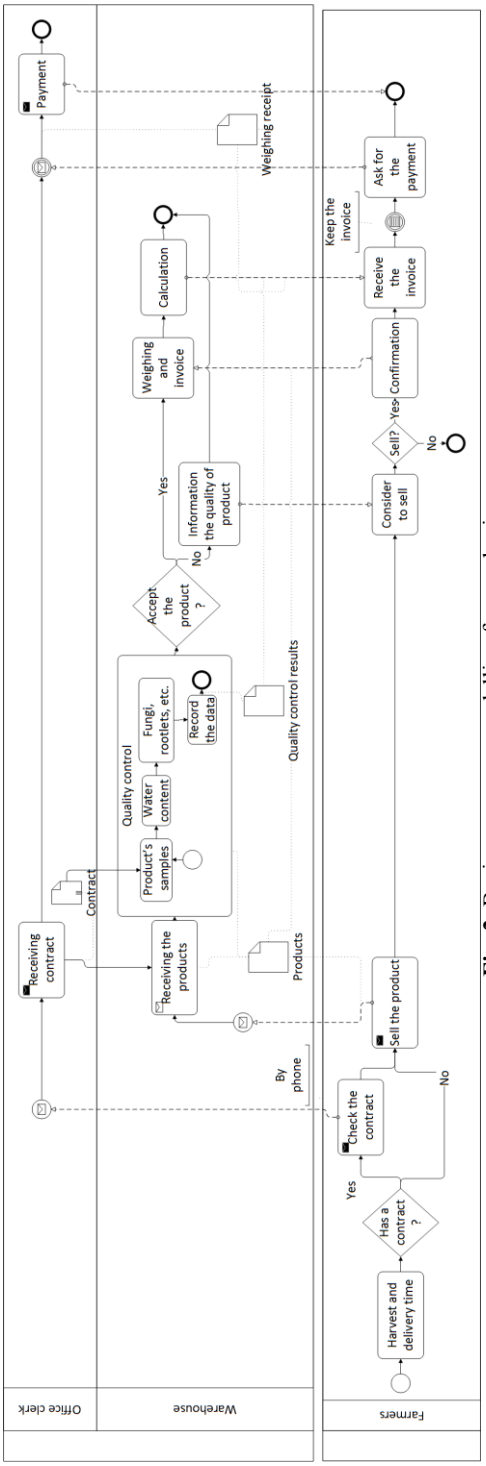

Fig. 2. Business process modelling for purchasing

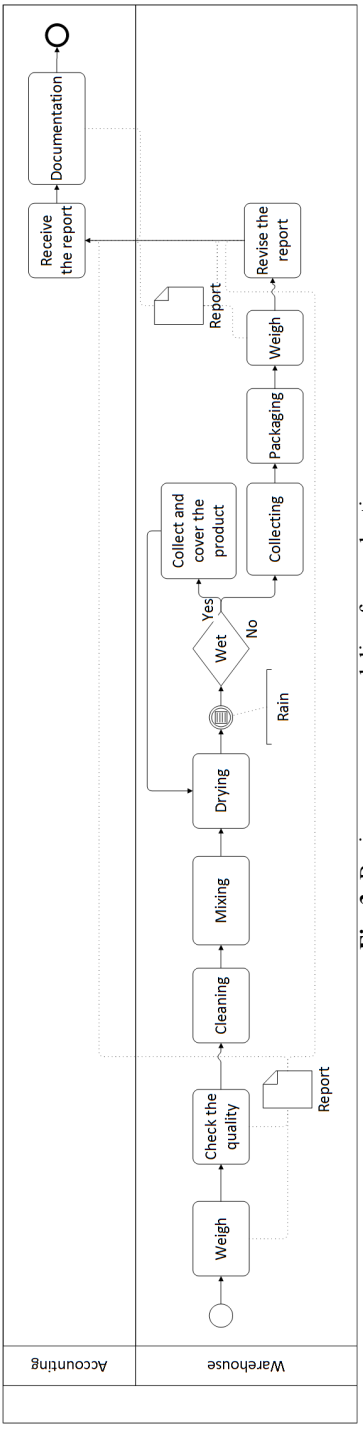

Fig. 3. Business process modeling for production

4.2. Maturity Phases

This research evaluates the maturity phases through six critical success factors which are strategic alignment, culture and leadership, people, governance, methods and informational technology [12].

Strategic Alignment. Strategic alignment is the linkages that connect organizational priorities and enterprise processes in order to achieve its business goals [11, 12]. In this company, the strategy to achieve more gain in profit and operational process already aligned. Based on the data, this company's strategic alignment reaches phase 2.

Culture and Leadership. Company culture implies the usual way that people behave inside. Culture is the values, beliefs, attitudes and behaviors that presents the company identification and public images. Leadership is crucial roles in supporting process design and facilitating cultural change throughout the company [11, 12].

In this agricultural company few years ago, when the management team introduced new business process or changing in operational company, there was certain resistance from some employees, especially employees is used to traditional way to work. The management began to arrange some trainings for changing the way of work. Nowadays, in company, the culture has been established gradually. Employees can accept new business process because they already realized that these changings made their work easier, more effective and efficient. These condition reflects to the phase 2 in Gartner maturity.

People. People are the individuals and groups who continually enhance and apply their knowledge and professional skill related company's business [11, 12]. In this company, staffs know and apply their skill in daily work. Unfortunately, they did not improve their skills, but just did the daily routine works. In same division, staffs could work together, but when they were asked to work cross division, they did not know about the regulation and business process. Based on this analysis, this company stays in phase 1.

Governance. Governance refers to the transparent accountability, responsibility, decision making and reward processes to guide actions [11, 12]. Based on the interview, it proved this company concerned to the regulation in arranging the production and purchasing rules. This company also deal with differences and contradiction between process and policy. As a result, the maturity level of the factor governance arrives phase 2.

Methods. Methods are the approaches and techniques to support consistent process for success of company [11, 12]. When this company wanted to implement a new business process, it will establish a person in charge of the control and improvement. Based on this fact, this company points out that on phase 2.

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Information Technology. This factors include the software, hardware and information management systems that enable and support process activities [11, 12]. IT plays many important roles in this company. Start from the contract with the farmer, finance, warehouse and inventory, this company use IT support to help dealing with data. By the support of IT, this company tries to streamline the process and information flow, which means this company stays on phase 3.

Based on the research findings, finally, it has evaluated the maturity level of the six critical success factors that influence the company. As the Table 2 presents the maturity level of company.

Table 2. BPM maturity level

	Phase 0	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
Strategic alignment	■	■	■			
Culture and leadership	■	■	■			
People	■	■				
Governance	■	■	■			
Methods	■	■	■			
Informational technology	■	■	■	■		

5 CONCLUSION

Business process modelling can describe the flow of business in this company. This model can help stakeholder conceive the tasks which are going clearly. With the model, stakeholder can make significant improvement in the future. The main problem facing in this agricultural company are: the performance of production process. Based on our analysis, we conclude several advices to help this company better

As the Table 2 provides the maturity level of the people is on phase 1, the maturity level of information technology achieves phase 3, and the maturity level of the other four factors including strategic alignment, culture and leadership, governance and methods have already arrived phase 2. These finding will help company to do big planning for improvement in the future.

In terms of IT, this research suggests company keep IT staying in the phase3 until the other factors reach phase 3 as well. In this way, company can focus more time and resources on the improvement of the other critical success factors.

Acknowledgments.

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