Analysis and Design of Knowledge Management System in Product Development

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Abstract—Product development activities in a company involve cooperation between functions, either from inside or outside the company. Various systems employed by these functions make the knowledge transfer from one function to another one becoming more difficult. This condition makes the product development process to be not optimal. In this research, we aim to analyze and design a knowledge management system that can help a company in managing its knowledge with respect to product development activities. The case of this research is a manufacturing company that develops arcade game machines. Our research produces knowledge management system which is capable in managing documents and communications during the product development process.

Keywords: product development, knowledge management system

I. INTRODUCTION

The economic success of a manufacturing company depends on the success of its products [1]. However to produce successful products evidently is not easy. Studies show that between 30 to 50 percent of the new products launched to the market are failed [2]. One of the reasons is the inability to manage the knowledge and translate it to successful new products.

Product development process involves cooperation between functions, which are R&D, Marketing, and Production [1]. R&D plays a role in the creative activity in product development which includes the creation, development, testing, and product improvement. Marketing acts as liaison between company and its consumers and is responsible to identify consumers' needs, market segments of the new products, and chance of products to success in the market. Production plays a role in designing and running the production system to provide and distribute the products.

Therefore, knowledge management system is needed to manage knowledge in the product development process. It is used to capture the created knowledge, to save the captured knowledge and to distribute them to all related functions. Information technology then can be used to capture, store and distribute process.

This research aims to analyze and design a knowledge management system (KMS) that can be used in the product development process, especially in a company that develops arcade game machines. The design phase is not only performed in the software side, but also in the electronic, mechanical, and product design. Thus, it broadens the spectrum of current research in the game product development by adding these aspects.

II. RELATED WORKS

Cheng, Hupfer, Ross, & Patterson [3] from the Collaborative User Experience group at IBM Research had been conducted to improve coordination and cooperation between the software developer team. The research project named Jazz was trying to add collaboration functionality to the Integrated Development Environment (IDE) Eclipse.

Natter, Mild, Taides, & Geberth [4] have developed software to help the Knowledge Management in Product Development process, particularly in the product concept development phase. The software is used to collect marketing data from costumer, data processing using statistic method, and displays the results in graphical form. Weber, Pohl, & Steinbach [5] also develop software for knowledge management in Product Development activity, particularly in the project management. The software that is called 'Semaril' includes features such as web interface, HTML editors, document management, project reporting and documentation, and universal database.

Lohmann and Niesenhaus [6] concluded the Knowledge Management as a fundamental need in the game product development. This is due to the increasing of complexity in the process and the growth of more specialized professions in that field. They proposed wiki as a tool for that purpose.

III. THEORETICAL BACKGROUND

A. Product Development

According to Product Development and Management Association, Product Development is the overall process of strategy, organization, creation of the concept, creation and production and marketing plan evaluation, and commercialization of a new product. The generic product development process consists of 6 stages with a decision-making stage inserted between each stage [1]. The decision-making stage is inserted to evaluate whether the development processes are still feasible to continue or not.

Each stage in the product development process can be explained as follow:

• Planning Stage which aims to perform assessment about the development of technology and target market and the alignment of corporate strategy.

• Concept Development Stage which aims to identify the needs of the target market. Various alternative concepts are developed and evaluated. The results will be submitted to the next stage.
• System Level Design Stage which aims to define the product architecture and to decompose the product into subsystems.
• Detailed Design Stage which aims to describe complete specifications of the product that will be made, including its geometrical size, material and standard as well as unique parts of the product and tolerance that is allowed.
• Test and Repair Stage which aims to build and evaluate prototypes of the products that will be built.
• Production Stage which aims to create products using the available production system. Before the product is manufactured and distributed, products will be tested by designated customers to find any bugs which may exist.

The structure of product development team can be divided into 2 groups: the core team and the support team. The core team consists of people which are directly involved in product development while the support team consists of peoples which are not directly involved but handle activities that support the smooth of the process.

The core team in product development game consists of 3 functions, which are design, manufacturing, and marketing department. The design function plays a role in the creative processes which are product development creation, development, testing and repair the products. In the video game development, this function consists of several teams, which are programmers, graphic artists, testers, and sound engineers. In the coin operated games development, this function also involves electronic and electrical designers, embedded programmer, and mechanical designer. The production function plays a role in designing and running the production system to produce and distribute products. In the video game development, this function includes product mastering and product duplication. In the coin operated games development, this section also involves assembling, laser cutting, molding, and screen printing functions. The marketing function acts as a liaison between businesses and consumers and responsible for identifying customer needs, determination of market segments for products that will be made, and identifying the opportunities for product to success in the market. This function includes sales, marketing, and technical support.

B. Knowledge Management

Becerra, Gonzalez & Sabherwal [7] define Knowledge Management as the implementation of various activities in discovering, capturing, sharing, and applying knowledge to improve its impact on the achievement of individual and organizational objectives in an effective cost.

Knowledge can be classified into 2 types, explicit and tacit. Explicit knowledge is a knowledge that is written, archived, spread (print or electronic), and can be used as learning material by others. While tacit knowledge is a knowledge that is not written and is still contained in one’s mind. Usually it is in the form of know-how, experience, skill and understanding.

Knowledge map is a visual illustration of tacit and explicit knowledge and the relationship between knowledge [8]. Its goal is to facilitate people to find knowledge that they need. Knowledge mapping can be done using several means, by using mind map, concept maps, fishbone diagram [9], or process map [10].

Knowledge can be changed from explicit to tacit or vice versa. This change is referred as the knowledge transfer. Knowledge transfer allows knowledge to spreads from a person to another, either directly or indirectly. Ikujiro Nonaka [11] formulated the knowledge transfer into a model consisting of four processes namely Socialization, Externalization, Combination, and Internalization. The model then is called SECI model (which comes from the first letters of each process).

C. Knowledge Management System

Knowledge Management System is an integration between the technologies and mechanisms that are developed to support the processes in the Knowledge Management. Based on supported Knowledge Management processes, Knowledge Management System can be divided into 4 categories [7], which are:
• Knowledge Discovery System: This system aims to support the development of explicit and tacit knowledge derived from previous data, information or knowledge.
• Knowledge Capture System: This system aims to support the capturing process of tacit knowledge in one’s mind and explicit knowledge resides in the documents, records, or papers.
• Knowledge Sharing System: This system aims to support the spread of tacit and explicit knowledge from person to person.
• Knowledge Discovery System: This system aims to support the process of knowledge utilization belongs to another without the need to relearn the knowledge.

IV. THE SYSTEM ANALYSIS

Knowledge management system is integration between the mechanisms and technologies of knowledge management. Both must be supported by knowledge management infrastructure. Therefore, before designing a knowledge management system, it should be analyzed the knowledge management processes that will be supported and the mechanisms, technologies and infrastructure of knowledge management which are currently used.

The first step of this stage is to understand current product development system. For this purpose, we analyzed company’s documents and interviewed some workers of the company. The analysis produces 2 things: the required or generated knowledge from each product development phase and the knowledge management processes that exist in each product development phase and technologies to support the process.

Next, we formulated the functional requirements. These requirements are explored detail into functional, structural, and behavioral model of the system. The followings are the functional requirements of our knowledge management system:
• Provides knowledge portal to display all product development knowledge assets and facilities available for knowledge transfer in the company.
• Provides collaboration facilities which enable corresponding parties to prepare project’s specification document.
• Provides document versioning control facility to archive all documents inserted to the system.
• Provides forum to facilitate discussion and idea exchange among members involved in the project.
• Provides project management facility to manage various activities in the product development process.
• Provides search facility that enables users to search source of knowledge quickly.

We model functional requirements by using use case diagram. This model describes the system from user perspective, i.e. what users can do with the system and how the system response the users. Figure 1 shows the use case model of the proposed system.

In addition to functional requirements, there are also non-functional requirements of the system. The non-functional requirement is a list of characteristics which are required by the system. These characteristics have indirect influence when users interact with the system. The following list is non-functional requirements of the knowledge management system to be constructed:

• The system connects all computers in the company.
• The system is easy to use by users from either technical or non technical background.
• The system is accessible through web browser.
• The system guarantees the security of knowledge.
• The system uses bahasa Indonesia to facilitate users who are not fluent in English using the system.

V. THE DESIGN

A. Class Diagram

Class diagram of the proposed knowledge management system can be seen in Figure 2. There are 10 classes in the system which can be divided into 2 parts. The first part consists of users of the system that includes Users, Groups, and Admin classes. The second part consists of representation from business domain that includes Projects, Documents, News, Notifications, Forum, Topics, and Feedback classes.

B. Entity Relationship Diagram

Entity Relationship Diagram (ERD) is a diagram that shows entities of the system, the attributes of each entity, and the relationship between entities. The diagram will be implemented as tables in the database. Figure 3 shows the ERD of the proposed knowledge management system.

C. Knowledge Management System Infrastructure

To determine the required infrastructure of the systems, we use gap analysis to find required infrastructures which are not supported by existing technology. For this purpose, we adapt the knowledge management system architecture proposed by Tiwana [12]. The result of gap analysis shows that current infrastructures have supported the proposed knowledge management system.
D. User Interface

Last, we design the knowledge management system’s user interface. This design produces three outputs which are the user interface structure diagram, the input designs, and the output designs. The user interface structure is presented by using Window Navigation Diagram. The input designs are parts of the system that will be used to enter information into the knowledge management system which consists of these components: Login, Searching and Upload/Download. The output designs are parts of the system that will display information to users. The output designs consist of notifications and search results. Figure 4 and 5 show screenshots of our knowledge management system.

VI. CONCLUSION AND FUTURE WORK

Through this research, we have analyzed and designed a knowledge management system for product development. The knowledge management system was developed to help manufacturing company to organize its knowledge when developing its products. Our research results showed that the design of knowledge management system for product development should focus on two functions which are documents and communications management. Some features have been established to help organizing documents and communication resources for each stage of product development.

In the future, we plan to assess the quality of our knowledge management system in order to collect necessary inputs to improve our system.

REFERENCES