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APPLYING MENTAL MODELS TO MAKING CONTROLLED CRITICALLY SAFE DECISIONS IN IT PROJECT MANAGEMENT

Over the past decades, numerous researchers and practitioners have focused on the use case modeling for information technology project management. However, few studies have examined ways to improve the discovery phase of an information technology project through modifying use case diagrams. In this work, a mental model approach is suggested to integrate a visualization stage into the discovery phase by creating a conceptual mental model before constructing the use case diagram. It has been established that designing a mental model by visualizing the end user's needs improves the ability of junior analysts to capture, analyze, and determine the user and functional requirements of information systems. Moreover, junior business analysts can extrapolate from the workflow presented in the conceptual mental model to determine the system's actions to benefit the associated actor, which must appear in the use case diagram. The paper describes the design of user precedents through a conceptual mental model. Altogether, the proposed approach's effectiveness in capturing, analyzing, and determining the requirements of information systems is measured in terms of accuracy, completeness, and simplicity.

Keywords: information technology project, project management, discovery phase, use case diagram, mental model, controlled critically safe decisions, business analysis

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ЗАСТОСУВАННЯ МЕНТАЛЬНИХ МОДЕЛЕЙ ДО ПРИЙНЯТТЯ КОНТРОЛЬОВАНИХ КРИТИЧНО-БЕЗПЕКОВИХ РІШЕНЬ В УПРАВЛІННІ ІТ ПРОЄКТАМИ

Упродовж останніх десятиліть багато дослідників та практиків зосереджують свою увагу на моделюванні прецедентів для управління інформаційними технологіями. Втім мало досліджень розглядають шляхи вдосконалення фази виявлення проєкту інформаційних технологій за допомогою діаграм прецедентів. У цій роботі пропонується підхід на основі ментальних моделей до фази виявлення вимог, що полягає в інтегруванні етапу візуалізації для побудови користувацьких діаграм. Структурування ментальної моделі з погляду користувачів покращує здатність бізнес-аналітиків-початківців для захоплення, аналізу та визначення функціональних вимог інформаційних систем. Крім того, аналітики можуть екстраполювати з робочого процесу, поданого в концептуальній ментальній моделі, щоб визначити дії, які необхідно виконати системою, щоб скористатися асоційованим актором, і це повинно з'явитися в діаграмі корпусу користувача. У роботі обговорюється гіпотеза структурування ментальної моделі у вигляді концептуальної ментальної моделі до визначення функціональних вимог за допомогою користувацьких діаграм. Запропонований підхід на основі ментальних моделей ґрунтується на незалежних та залежних змінних. Незалежною змінною є кількість замовлень від клієнтів; водночас залежними змінними є загальна якість системних функціональних вимог, якість кожного випадку використання в термінах правильності та повноти, якість посилань із погляду правильності та повноти, надлишкові зв'язки або використання випадків. Застосування концептуальних ментальних моделей може викликати певні недоліки. Наприклад, некоректне впровадження ментальної моделі під час фази виявлення може призвести до проблеми валідування зібраних функціональних вимог. Загалом, ця проблема поділяється на чотири групи: висновок, внутрішня перевірка, дизайн та зовнішня перевірка.

Ключові слова: проєкт інформаційних технологій, управління проєктами, фаза виявлення, діаграма прецедентів, ментальна модель, контрольоване критико-безпекове рішення, бізнес-аналіз.

Problem statement

Within most information technology (IT) projects, discovering requirements for developing information systems (IS) often rely on controlled critically safe decisions made by different stakeholders. As so, practitioners utilize the Use Case Diagrams (UCDs) [1] to define functional system requirements to perform the robust discovery phase. A sample of a UCD is presented in fig. 1.

The UCD has been considered a valuable and easy-to-use tool for representing and specifying various project requirements within the business analysis (BA) community. In general, UCD comprises two components: 1) a graphical diagram to model and represent customer requirements, and 2) use case descriptions to elaborate and specify these requirements in detail.

The presented study aims to facilitate the discovery phase performed by junior BA practitioners. We propose a novel approach based on mental models to improve UC diagrams while identifying, capturing, and specifying functional system requirements.

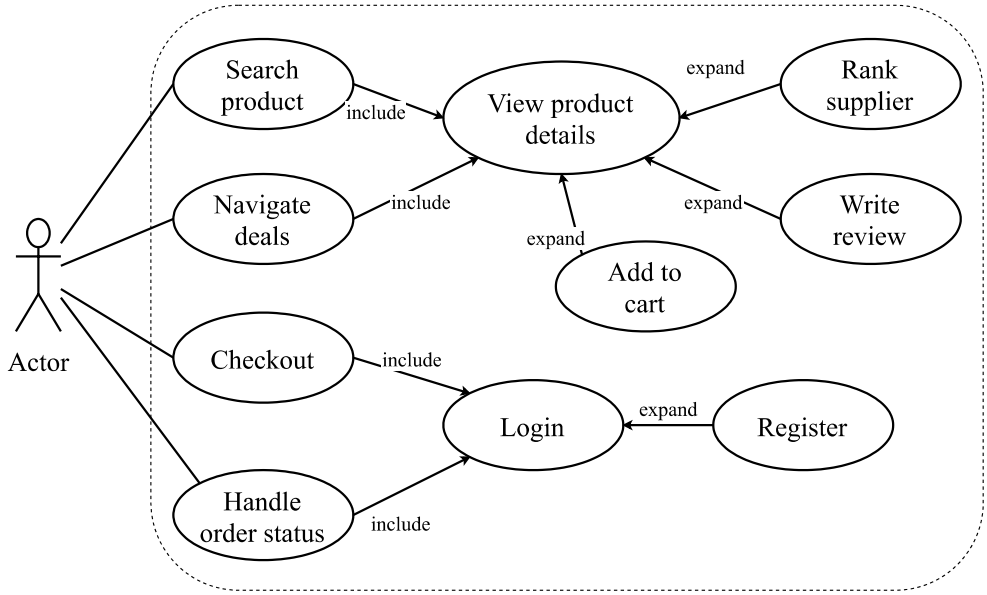

Fig. 1. A use case diagram for an IT project

Analysis of recent research

Over the last decades, numerous studies have aimed to improve the quality of UC model outcomes through comparison-based experiments. For instance, in [2], the authors enhanced UC descriptions by proposing advanced guidelines to write good use cases, while [3] were focused on improving UC descriptions inspection checklists with screen mockups. Another work [4] showed that using predefined templates allows designing a UCD easier to comprehend and read comparing to guidelines without specific details.

Throughout its history, the IT domain has challenged the issue of interpreting and explaining computational results. And to tackle this issue, mental models might be a feasible solution. The term "mental model" originates from the fields of cognitive psychology and human-computer interaction (HCI) [5, 6]. In [7], authors argued that "a mental model represents a person's thought process for how something works, i.e., a person's understanding of the surrounding world." For practical use, mental models require some physical representation, commonly verbal or spatial [8, 9]. For example, an IS can be viewed as a conceptual mental model (CMM) – a diagram expressing the structure of an IS from the user's perspective. The model, in this case, is created in a controlled process according to the preset guidelines.

Another recent study [9] discussed the cognitive significance of visualization for software engineers for whom an IT project perceives as a combination of various tasks; visualization allows covering all business requirements as a whole. Thus, a CMM is a graphical representation of the user's mental activity and behavior within an IS. An example of a CMM is illustrated in fig. 2.

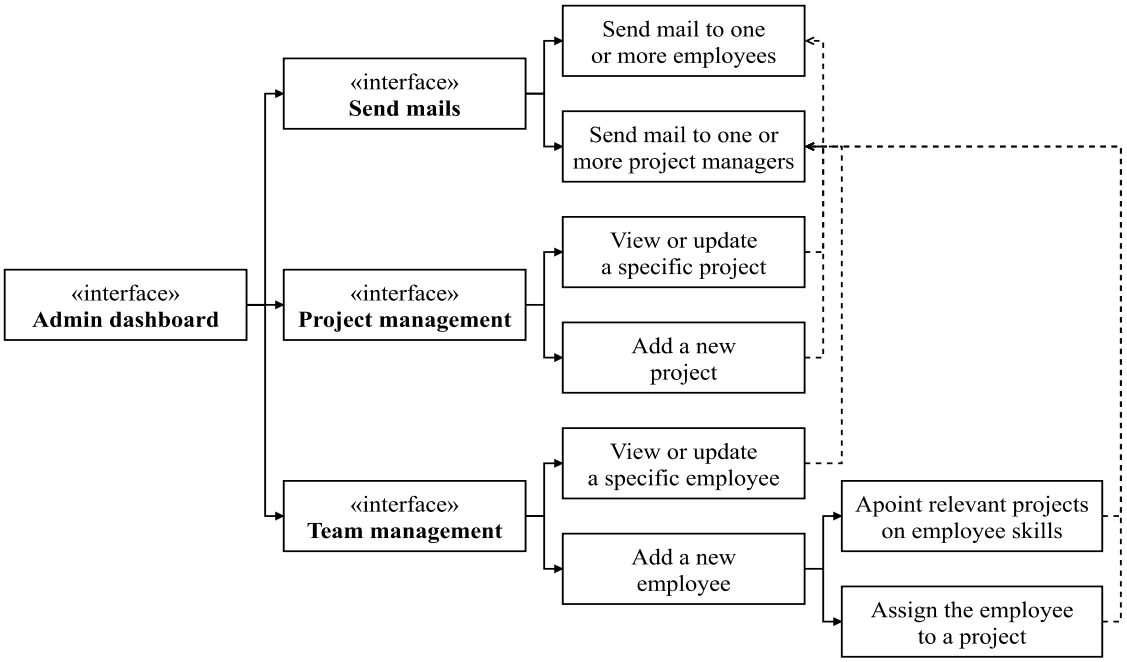

Fig. 2. Definition of user's work processes through a conceptual mental model. Bold rectangles in the scheme depict the user interface, while ordinary rectangles define a screen or a function. User actions in the information system are specified by arrows

Based on the mental model approach, it is proposed to apply the user demands' visualization at the beginning of the discovery phase, which implies formalizing a CMM before designing a UCD. It should be noted that both a CMM and UCD refer to similar components of an IS, such as actors, relations, functionality, etc. Formalizing a mental model in terms of user needs can improve the ability of junior professionals to collect, analyze, and define system requirements for information systems. In particular, junior business analysts can extrapolate from the IS workflow presented in the CMM to determine system's actions to benefit the associated actor, which must appear in the further UCD. Finally, the visualization of user demands through a CMM provides improvement in the accuracy, completeness and simplicity of the system requirements definition by inexperienced practitioners.

Conceptual mental model

According to the literature review and practical observations, those junior professionals responsible for collecting system requirements for the product who "imagine" the future IS's functionality and its workflow in terms of user demands during the discovery phase perform analysis and identification of actors and relationships between them more effectively and better model these relationships under appropriate elements of UCD. Motivated by this insight, an integrative approach is suggested to benefit the discovery phase while providing UC modeling. The proposed approach is aimed to enhance the discovery phase by structuring the "imaginary" process to a formal stage of visualization, which must be performed before creating a UC diagram. Therefore, team members within an IT project must formalize a CMM based on external data collected from key stakeholders before the analysis and definition of IS for a UCD. Fig. 3 depicts a scheme of the proposed approach implemented to an IT project.

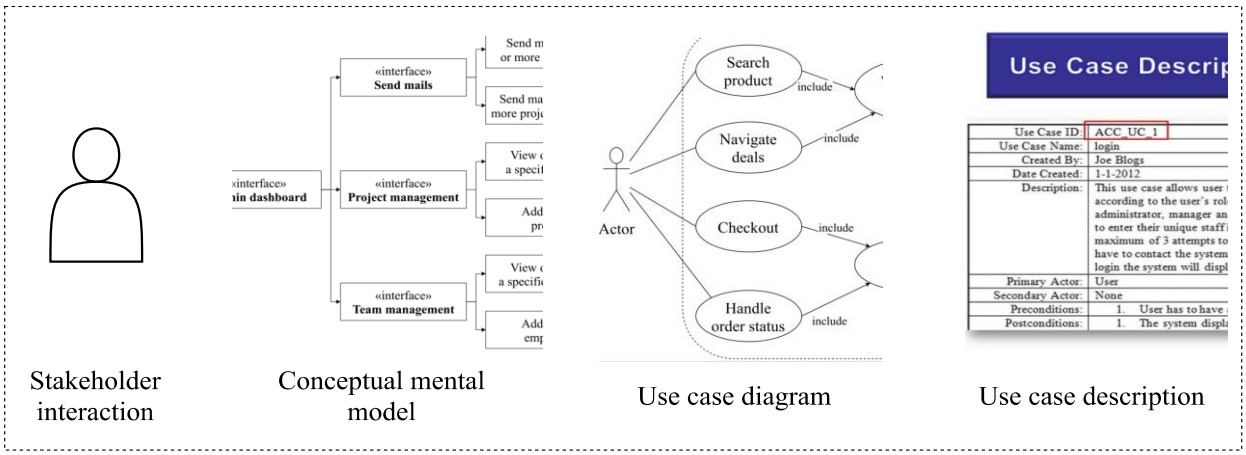

Fig. 3. A scheme of a discovery stage with a conceptual mental model before creating a use case diagram.

Our mental model approach also suggests quality criteria to evaluate the possible outcome of an examined discovery phase. Based on a quality evaluation framework [11], three quality indicators were chosen: accuracy, completeness, and simplicity. The accuracy indicator determines whether the model corresponds to the data modeling methodology and is measured by the number of errors in the created model. Completeness is determined by the number of user system requirements that are not present in the model. Simplicity determines the number of subjects and relationships in the model, i.e., shows how simplified the model is.

The independent and dependent variables of the proposed approach are summarized below:

1. Independent variables: request to perform a task within an IT project.

2. Dependent variables:

a) the estimated quality of the defined user and functional requirements, scored from 0 to 60;

b) the estimated quality of each use case by accuracy and completeness: 0 – absent, 2 – incorrect, 4 – correct;

c) the estimated quality of the defined connections between actors and use cases by accuracy and completeness: 1 point is deducted from the final score if the connection is redundant, 2 points are subtracted from the final score if the use case is redundant.

This section discusses the possible disadvantages of the proposed mental model approach. Incorrect results of the cognitive model's implementation to the discovery phase may manifest due to the validation of the collected requirements. This problem can be divided into four components: conclusion, internal validation, design, and external validation. Conclusion concerns the credibility of the inferences reached within the discovery phase. Internal validation refers to factors that might affect the dependent variables. Construction refers to how mental models are reflected in actual measures. Finally, external validation concerns the generalization of results, both to the study of the population and to other settings.

Conclusion

The present study proposes a mental model approach which implies including a visualization stage before the discovery phase for project assessment in the information technology domain. This approach aims to increase the efficiency of junior business analysts and project managers in collecting, analyzing, and defining custom and functional requirements for information system development. Applying mental models to the discovery stage will enhance the

construction of user case diagrams by accuracy, completeness, and simplicity. Furthermore, future research needs to examine more closely how to transform a set of conceptual mental model elements into a set of use case diagram constructs.

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