The Vendor and User Organizations Characteristics for COTS Software Evaluation and Selection

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ABSTRACT

Since the Commercial off-the-shelf (COTS) software become widespread components in the market for building the systems with less time and cost, the COTS evaluation and selection becomes a non-trivial task. There are many models attempted to propose a set of characteristics for evaluating and selecting COTS software. However, these models have concentrated on the functional and quality characteristics of COTS software, leaving other effective characteristics related to vendor (the organization that developed, support, and realized COTS software) and user (the organization that integrated and used COTS software) organizations. Therefore, this paper proposed a set of important characteristics relevant to the vendor and user organizations that play important role to discriminate between COTS alternatives in COTS evaluation and selection process. Most of the related studies have been analyzed and carefully studied in the literature to identify and propose these characteristics together with their attributes and associated metrics.

Keywords: Vendor organization characteristics, User organization characteristics, COTS evaluation and selection, COTS characteristics.

I. INTRODUCTION

Organizations of today' computing and information systems expect systems development to be performed in short time and less cost with more productivity. Therefore, the paradigm shift to Commercial off-the-shelf (COTS) components become inevitable in the field of software development and business practices (Hill et al., 2004). COTS software emphasizes buying commercial capabilities rather than building unique ones from scratch. Organizations that adopt a COTS-based system (CBS) approach generally expect either more rapid or less costly system construction. These organizations also hope to stay in step with the current technological advancements in the competitive marketplace (Suleiman, 2008).

Using COTS software can provide a beneficial effect in decreasing the times, costs, and efforts of systems development, while improving the functionality, flexibility, reliability, and reusability of the final system due to the (re)use of software components already tested and validated . For example, NASA (National Aeronautics and Space Administration) has successfully employed COTS products in reengineering the Hubble Space Telescope Command and Control system (Rawashdeh & Matalkah, 2006) (Pfarr & Reis, 2002).

In COTS-Based System development (CBSD) process, effective evaluation and selection of COTS software products is one of the key aspects of the system development life cycle. It is often a non-trivial task because its success largely depends on the accurate understanding of the capabilities and limitations of the individual COTS candidates (Baharom et al., 2011).

For success in COTS software evaluation and selection process, it is essential to identify the functional and nonfunctional requirements to identify the evaluation criteria. Identifying the non-functionality requirements of COTS software plays a vital role to improve the discrimination process between competing COTS software alternatives that already meet the core functional requirements. For instance, if two COTS products provide the same function (i.e. they have similar functionality), non-functional characteristics should be used in the evaluation and selection process as further and decisive criteria (Breitman et al., 1999; Tarawneh et al., 2011).

Despite most researchers and developers have concentrated on the functional and quality aspects of COTS software, they leave aside the (difficult) treatment of it and extra properties. this kind of

properties deserves special attention, since they are important in any commercial evaluation process (Zschaler, 2010).

Accordingly, the characteristics related to the vendor organization that develop, support, realize, and upgrade COTS software, as well the characteristics associated to the user organization (COTS implementation environment) that acquire and integrated COTS software should be carefully considered when evaluating COTS software (Bertoa & Vallecillo, 2002). The lack of a careful consideration of these characteristics might raise the potential risks of COTS failures and increases the final system costs. For instance, if the vendor organization's financial position is unstable, it might causes an unexpected bankruptcy which might result the vendor to go out of business and leaving the user organization alone with unsupported COTS software. Therefore, knowing the financial position of the vendor organization before entering into a long-term relationship could help to avoid the supporting disruptions (Iribarne et al., 2001). Besides, the user organization has a set of characteristics (constraints) (i.e. price, users skills, development process, and polices) that should be considered when selecting COTS software, (Beus-Dukic, 2000).

Additionally, there is a lack of information that can help the evaluators' team to select more reliable and stable vendor that support COTS software in long term, such as financial state and supportability. In addition, there is an absence of any kind of metrics that could help evaluate vendor and user organizations characteristics. Most of the studies that have been mentioned to these characteristics do not explain how to measure them such as STACE approach pointed out the vendor organization reputation and stability without explains how to measure them (Bertoa & Vallecillo, 2002; Beus-Dukic, 2000).

This paper proposes a set of common characteristics, attributes, and their corresponding metrics that play important roles for evaluating and selecting COTS software. This paper is organized in 5 sections. After this introduction, section 2 shows the related studies that addressed COTS evaluation characteristics. Section 3 presents the significant characteristics associated with the vendor organization, while section 4 presents the user organization characteristics that help to select applicable COTS software. Finally, this paper was concluded by section 5 that summarizes the paper and presents the associated future work.

II   RELATED STUDY

Both theory and practice of COTS software evaluation and selection focus on functional and quality characteristics without providing adequate treatment with vendor and user organizations characteristics. Furthermore, many models have been proposed to present set of characteristics for COTS evaluation and selection, for example: the quality characteristics for COTS components by (Bertoa & Vallecillo, 2002), the new software quality model for evaluating COTS components by (Rawashdeh & Matalkah, 2006), and commercial off-the –shelf component quality model proposal (Kalaimagal & Srinivasan, 2010). All of these models have been built based on the international quality model (ISO9126), which focus on the general software quality characteristics. In fact, while the COTS software are influenced by different areas/sides (such as vendor organization characteristics and user organization characteristics) that play important role to evaluate and select the suitable COTS software, the quality characteristics that were proposed by those models focuses on one side and neglected others important sides. Consequently, the quality characteristics are not enough to evaluate and select the suitable COTS software.

This is also true for COTS software selection methods which most of them fail to take these characteristics into account. Or even if they do, their treatment is too simplistic. Such of these methods is Off-The-Shelf Option (OTSO) method (Kontio, 1995). It is one of the first COTS selection methods. It focuses on the quality characteristics and the financial issues, and neglected the characteristics related to vendor organization characteristics.

COTS-Based Requirements Engineering (CRE) (Alves & Castro, 2001) method highlights the important of non-functional requirements and how to represent them. But this method also rely on quality characteristics and ignore the others kinds of characteristics.

In the Social-Technical Approach to COTS Evaluation (STACE) (D. Kunda & Brooks, 1999) method, a set of characteristics related to quality and vendor have been implicitly presented, and it also ignore other characteristics related to the vendor and user organizations.

Accordingly, the two kinds of studies (the models and the methods) that handle COTS evaluation and selection have neglected the impact of the vendor and user organizations' characteristics in the

COTS evaluation and selection process. In addition, some of them presented some of these characteristics without any details like how to measure them in real life.

III VENDOR ORGANIZATION CHARACTERISTICS

The organization that developed, maintained, upgraded, and supported chain of COTS products in the market has a significant effect in the selection process and success of the final project (Tarawneh, Baharom et al., 2011) (Nikoukaran et al., 1998), since the COTS vendor organization is the only player who can control the future evolution, release, and modification of source code of COTS software, it is the only one that can provide a long-term relationship and essential support for integrating COTS. Therefore, evaluating the vendor organization is inevitable to keep a good communication with good vendor during and after purchasing of COTS software (Abts et al., 2000; Mujeeb-u-Rehman et al., 2005).

Consequently, a set of characteristics are proposed to investigate the quality of the vendor that the user will deal with. Precisely, despite the lack COTS vendor organization studies, most of the studies that have related to the COTS vendor organization characteristics have been reviewed and carefully studied, such as (Beus-Dukic, 2000; Couts & Gerdes, 2010; Lin & Hsu, 2007; Mujeeb-u-Rehman, et al., 2005; Tam & Tummala, 2001). As a result of this study, the important characteristics for evaluating vendor organization have been investigated and identified in order to provide enough information for discriminating between the COTS software alternatives.

Ultimately, the common vendor organization characteristics that play important role to evaluate and select COTS software have been classified into three main characteristics: vendor reputation, vendor stability, and vendor supportability. Each of these characteristics has been decomposed into attributes, and their metrics. These characteristics were explained as the following.

A. Vendor Reputation

The reputation is defined as how all the users view the vendor organization. The reputation directly impacts on the vendor organization's ability to success in the market and ultimately builds value for the vendor organization between users (Caruana & Chircop, 2000).Therefore, before making the decision of purchasing from any vendor, it is important to know what the other

users think about this vendor (D Kunda, 2002). The vendor reputation is decomposed into the following attributes: certification, customer reference checks, market coverage, management quality, competence, innovativeness, and the implementation timelines. For more accuracy, all of these attributes are measured by a set of different kinds of metrics as stated in Table 1.

Table 1. Reputation Characteristic.

Attributes	Metrics	Types
Certification	Employee	Presence
	Development process	Presence
	Software product	Presence
Reference checks	List of clients	Presence
Market coverage	The number of Customers	Integer
Management quality	Operations management	Level
	Customer satisfaction	Level
	Risk management	Level
Competence	Development process	Level
	Technology	Level
Innovativeness	Innovative product	Level
Implementation timelines	The committee in timelines	Level

B. Vendor Stability

Vendor stability should be assessed to ensure that the vendor organization will be around in the future for supporting and upgrading COTS software (Lin & Hsu, 2007). It has important role to determine how stable is the vendor organization in order to decide whether a long relationship with this vendor can be built or not (Couts & Gerdes, 2010; Teltumbde, 2000). In reality, there are a set of attributes that can indicate whether the vendor is stabile or not, as shown in Table 2. For example, the financial position of the vendor organization indicates whether the organization will be in the safe side or it is going to be bankrupt. Also the existence of long-term strategy in the vendor organization indicates how it is planning to survive and compete in future.

Table 2. Stability Characteristic.

Attributes	Metrics	Types
Financial	Financial ratio	Level
Track record	Time in business	Integer
	Time in development this software	Integer
	The first developed date	Date
	Growth the organization	Level

	Organizing	level
Employees	Number of employees	Integer
Strategy	Long-term strategy	Presence

C. Vendor Supportability

It is the ability of the vendor organization to provide a set of services, maintenances, and upgrades during and after the software product implementation. The vendor's supporting starts when the user selects COTS software and signs the contract with the vendor that can explain how the vendor will support the software (Boehm & Abts, 1999; Lin & Hsu, 2007).

As shown in Table 3, the delivery (performance, date, and functions) and user training are the attributes to measure the vendor supportability during software implementation, while the user and software support measure the supportability of the vendor organization after software implementation.

Table 3. Supportability Characteristic.

Attributes	Metrics	Types
Delivery	On time delivery performance	Level
	Confirmation date of delivery	Level
	Confirmation software functions	Level
User training	Training courses	Level
	Training tool/technology	Level
	User documentation	Level
User support and communication	Help desk support	Level
	User queries/faults	Level
	Remote or online support	Level
Software support	Releasing functional software upgrade	Level
	Software upgrade path	Level
	Services warranty support	Level

IV USER ORGANIZATION CHARACTERISTICS

User organization represents the environment where the COTS software will be applied. As well as the COTS software are developed by different vendors and use different development processes, programming languages and technologies user organizations also have their own technology, process development, programming language, infrastructure, user's requirements, skills,

experience, etc. Thus, any successful evaluation and selection process should also carefully consider the variety of user organization characteristics (Beus-Dukic, 2000; Tarawneh et al., 2011).

However, since the lack of existing studies related to the user organization characteristics for COTS evaluation and selection, common characteristics have been identified and adapted from different fields. As a result, the characteristics that have an important impact in selecting the suitable and the well-matched COTS software with the user organization properties have been classified into four main characteristics: system platform characteristic, software development environment characteristic, culture characteristic, and financial characteristic. All of these characteristics were discussed below.

A. System Platform

System platform is a keystone in any organization. It consists of hardware and software platforms. The hardware platform can be simply defined as a family of architectures to launch software, while the software layer that wrap the essential parts of hardware platform are called software platforms such as I/O subsystem via device drivers, and network connection via the network communication subsystem (Ferrari & Sangiovanni-Vincentelli, 1999).

In most cases, the user organization does not have enough resources to upgrade its system platform to meet the COTS software conditions, but it still has the choice to select the most compatible COTS software with its system platform from different COTS alternatives. So, the compatibility of the COTS software will be based on the values of metrics associated with each of the hardware platforms such as memory system, and software platform such as the existing operating system as shown in Table 3.

Table 4. System Platform Characteristic.

Attributes	Metrics	Types
Hardware platform	processing unit performance	Level
	Memory system	Level
	Data transfer system	Level
Software platform	current operating system	Presence
	current middleware (e.g. CORBA standard)	Presence
	communication applications	Presence

B. Software Development Environment

Software development environment includes everything required by the developers to adapt and integrate COTS software in the final system

(Eeles, 2011). As the COTS software products come from different software development environments (vendor organizations), there is a potential risk of integration failure to integrate in the current development environment (user organization). Therefore, it is important to consider the software development environment characteristic during the evaluation and selection COTS software. In order to determine whether the COTS software can integrate with the current development environment or not, the software development environment characteristic is decomposed into three attributes: the current development process, the current technology, and developers' skills and knowledge. More details in Table 5.

Table 5. Software Development Environment Characteristic.

Attributes	Metrics	Types
Process	development process s *(tasks, roles, processes)*	Level
	Supplementary process *(standards, guidelines, checklists, templates)*	Level
Technology	Development tools *(Integration and configurations tools, install and scripts tools, debugging and testing tools, etc)*	Level
People (developers)	Skills/knowledge	Level
	Training courses	Level

C. Culture

Culture is the characteristic that describes the environment which surrounded the users of the software in the organization. It is a powerful element that shapes the work environment relationships, work process, and users' performance in the organization. The way of working, behavior, and interaction between the employees during work in the organization shapes the organization culture (Cabrera et al., 2001).

Consequently, the culture characteristic plays an important role to the success of any system development and the process of integrating COTS software. Therefore, the process of evaluation and selection COTS software should consider the culture characteristic as an important characteristic to distinguish between COTS alternatives. For instance, does the COTS software support the current relationships between the employees; does the COTS software compatible with current users skills/knowledge; does the COTS software support the current process flow, polices, rules, symbols, etc. Table 6 shows the required culture characteristic that should be taken into account when selecting COTS software.

Table 6. Culture Characteristic.

Attributes	Metrics	Types
User culture	expertise	Level
	knowledge/skills	Level
	expectations	Level
Organizational culture	behavior *(General operating norms, Cooperative, Interaction)*	Level
	Symbols	Level
	Language	Level
	Policies	Level
	Procedures and roles	Level

D. Financial Characteristic

Any system development project will be depended on the financial position of the organization. An organization financial position represents the financial ability to build or purchase, and then to select the required software. So, the financial position of the organization can be considered as the decisive factor in the evaluation and selection process (Beus-Dukic, 2000). The selection of COTS software decision depends on the financial ability of the organization to cover all the costs associated to buying and integrating COTS software (Kontio, 1995). In this paper, we classified the associated costs with selecting COTS software process into two attributes: the acquisition costs that represent the costs during the COTS selection such as the price, training cost, and delivery cost. The second cost is the further costs that represent the costs after selecting the COTS software such as adapting cost and integration cost. Table 6 shows all kinds of costs.

Table 6. Financial Characteristic.

Attributes	Metrics	Types
acquisition costs	COTS price	Integer
	Delivery (installation) cost	Integer
	Maintenance or upgrading cost	Integer
	Training cost	Integer
	Infrastructure upgrading cost	Integer
further development costs	Mismatching/adapting cost	Integer
	integration costs	Integer
	COTS testing cost	Integer

V. CONCLUSION

In this paper, we have presented the set of important characteristics associated with vendor such as reputation, and stability, and user organizations such as system platform and financial characteristics for success in COTS evaluation and selection process. These characteristics were proposed based on careful

study on the related studies in the literatures. In order to be clearer and more accurate, these characteristics were presented together with a set of different kinds of metrics to measure them.

As a future work, our long-term objective is to establish a standard model that include the common evaluation characteristics that are required to evaluate and select the fitness COTS. Therefore, the proposed vendor and user organizations characteristics will be integrated with quality and other kinds of characteristics that have been proposed by the previous studies.

ACKNOWLEDGMENT

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