Information Systems Reuse:
Organizational Focus

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I. Introduction

While a great deal of progress has been achieved in enhancing the productivity and performance of computer hardware, little progress appears to have occurred in improving the productivity of software development. There have been several decades of intensive research on and steady increase in software productivity, and continual introduction of new development methodologies such as information engineering and higher level programming languages. However, the explosive needs for information systems development in the company and the increasing demand for the software industry still remain unsatisfied. As a realistic approach to this problem, information systems (IS) reuse is being regarded by many researchers as a key factor in improving information systems productivity and quality, and meeting time and cost targets.

Over the last decade much research effort has been undertaken to enhance IS reuse especially from the technical and engineering approach (Jones 1990, Dodd

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1994). For instance, object-based development methodology and repository-based integrated CASE (Computer-Aided Systems Engineering) environments are good examples of such approach. These approaches have suggested new and innovative ideas for increasing IS reuse such as developing business component. But it does not seem that the approach actually has really resulted in a significant and substantial impact on IS reuse level of organizations, even though they may have a great potential for the reuse. There seems to be no evidence that many organizations have a high rate of information systems reuse, yet.

The importance of non-technical factors in facilitating IS reuse has been gaining attention from researchers (Joos 1994, Fafchamps 1994, Frakes & Isoda 1994). The basic theme of this view is that even the best technical and engineering tool can not produce a high level of IS reuse. Communication barriers among IS professionals or some other organizational factors might significantly affect IS reuse level in the organization. Also, such reuse should be economically feasible and proven to offer economic payoff. Especially, managerial factors in facilitating IS reuse have been mostly overlooked by IS reuse researchers (Fafchamps 1994). While many suggested that human and organizational factors are the important success factors to reuse (Joos 1994, Fafchamps 1994, Frakes & Isoda 1994), these have not yet been explored and investigated sufficiently. A possible reason is that many researchers in IS reuse area have computer science or engineering background. They are likely to be more familiar and comfortable with engineering and technical view of IS reuse. But the human and organizational issues are gaining more attention and interest from researchers. When we look at the reality of IS reuse of today's organizations, many problems appear to emerge from human and organizational ends, not technology or methodology.

This study basically deals with organizational factors that are considered to be important in promoting IS reuse. The purpose of the research proposed here is to identify a comprehensive set of organizational factors related to IS reuse. To achieve this purpose, the paper first delineates the concept and research

streams of IS reuse by reviewing existing literature on IS reuse. The implications of the effect of organizational characteristics on IS reuse are then discussed relating with development productivity. This paper concludes with the limitations and future research directions and their implications for researchers and practitioners.

II. Information Systems Reuse: Conceptual Clarification

Information systems (IS) reuse is broadly defined as the use of knowledge or artifacts from existing systems to build new ones (Frakes & Isoda 1994). It plays a role in improving the software quality and productivity. Over the past decade, researchers and practitioners have been trying to enhance the reusability of information systems. While many organizations appear to be reusing software in certain ways, the degree, form, and method of reuse may vary depending on the situations of the organizations. There are different perspectives to view IS reuse. Prito-Diaz (1993) classifies reuse by six criteria: substance, scope, mode, technique, intention, and product. According to this paper, the *substance* defines the essence of the items to be reused; *scope* defines the form and extent of reuse; *mode* defines how reuse is conducted; *technique* defines what approach is used to implement reuse; *intention* defines how elements will be reused; *product* defines what work products are reused. Researchers have also emphasized systematic reuse, not just sporadic or adhoc reuse (Frakes & Isoda 1994, Prieto-Diaz 1993). Reuse applies not only to program source-code, but also everything associated with software development, including knowledge. These reusable artifacts are also classified into different categories by different researchers. Jones (1990) categorizes reusable artifacts into four types: data, architecture, design, and program.

Another stream of research has focused on how to measure reuse in the organization. This is usually called reuse metric area. Frakes and Terry (1996) provide comprehensive reviews and summaries of prior research on reuse

metrics and models. They identified six categories of reuse metrics and models: cost-benefit analysis, maturity assessment, amount of reuse, failure mode analysis, reusability assessment, and reuse library metrics. They explained that *cost-benefits models* include economic cost/benefit analysis as well as quality and productivity payoff; *maturity assessment* models categorize reuse programs by how advanced they are in implementing systematic reuse; *amount of reuse* metrics are used to assess and monitor a reuse improvement effort by tracking percentages of reuse for life cycle objects; *failure modes analysis* is used to identify and order the impediments to reuse in a given organization; *reusability* metrics indicate the likelihood that an artifact is reusable; *reuse library* metrics are used to manage and track usage of a reuse repository. They also said that organizations often experience the need for these metrics in the order presented above.

Most of the conceptual research on IS reuse is based on the assumptions of rational reuse behavior. Conceptual research usually deals with the object of reuse, perspective of reuse, assessment of reuse level, maturity or capability, critical success factor or prohibiting factor, and migration strategies. Different researchers have developed different models (Hudson & Koltun 1991, Davis 1993). Reuse maturity model and reuse capability model, in particular, illustrate well the evolution of IS reuse in organization and help them assess their reuse level and migrate to higher stages.

Ⅲ. Factors Facilitating IS Reuse

〈Figure 1〉 displays a model of the links between IS reuse, technical/non-technical factors and IS reuse outcomes. It shows reuse-promoting factors such as technical and non-technical factors. The reuse-promoting factors are factors that actually facilitate IS reuse level or help make it a reality to develop information systems using reusable parts. Technical factors are those that support IS reuse technically, and comprise new paradigms or methodologies of IS

development, new programming languages, new technologies, and so on, whereas non-technical factors include organizational, economical or legal factors that may have an impact on IS reuse.

⟨Figure 1⟩ Linkages between IS reuse, Technical/non-technical factors and Outcomes
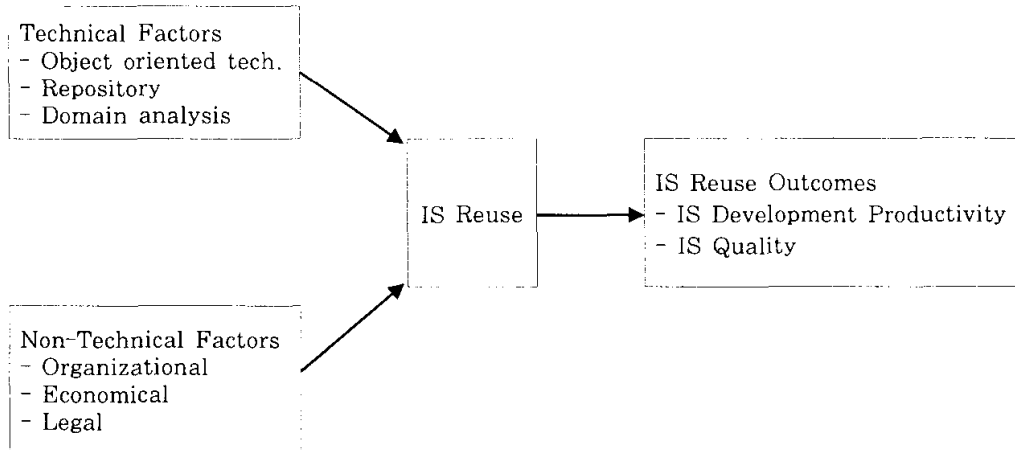
Frakes and Isoda (1994) suggests critical success factors to systemic IS reuse, that includes management, measurement, legal, economics, design for reuse, and libraries. These reuse-promoting factors can be classified into technical and non-technical categories. In addition, Frakes and Fox (1995) study factors that might affect IS reuse level. These factors can be also grouped into technical and non-technical types. They found both technical and non-technical factors affect IS reuse level.

Economic factors are ones that try to assess economically the feasibility of IS reuse. Economic benefit of reuse may, therefore, be viewed as a prerequisite in order to promote it. For example, reuse should help reduce IS development cost or increase returns on IS investment. On the other hand, organizational factors refer to the organizational environment promoting IS reuse. We posit later on that organizations have to remove the barriers to IS reuse and generate necessary motivations for their IS employees to pursue IS reuse effectively.

The figure also displays the performance or outcome of IS reuse. Many

researchers on IS reuse assume that IS reuse could produce higher level of IS development productivity and IS quality. But, a few researchers have been trying to validate this relationship between productivity and quality and IS reuse (Banker & Kauffman 1991, Lim 1994). A review of existing literature (e.g., Joos 1994, Fafchamps 1994, Frakes & Isoda 1994) suggests that the area which has gained least attention and has not been investigated enough seems to be non-technical factors, more specifically organizational factors in facilitating IS reuse.

1. Technical Factors

Perhaps one of the key factors that enable IS reuse as a realistic alternative to increase IS productivity and quality is the technological breakthroughs in system development, and more specifically, recent introduction of object paradigm in system development (Korson & Mcgregor 1990, Graham 1994, Desfray 1995). Therefore a number of technical IS reuse research have been performed relating to object technology.

First of all, much research work has been done in system development methodology area (Booch 1994, Dodd 1994). Object-based system development or component-based system development are good examples of technical research of IS reuse from system development methodology point of view. Dodd (1994) mentions that a component-based development approach involves two development streams: component fabrication and assembling an application. He asserts that a common repository is the essential enabling technology for component-based application.

Object-oriented analysis, object-oriented design, and object-oriented development have, respectively, been investigated by a group of researchers (Bailin 1989, Coad 1992, Henderson-Sellers & Edwards 1990). Basically, they suggest that object-oriented view or paradigm can be a better alternative to traditional and structural method. However, unfortunately, there seems to be many unsolved issues in this area such as lack of standardization of methodology and lack of

supporting computer tools. The consistent methods from analysis through implementation, which are simple, clear and easy to understand and learn regardless of programming language used, are needed.

Domain analysis and design patterns for developing reusable objects have gained attention from researchers. Prieto-Diaz (1993) asserts that domain analysis is the key to systematic, formal, and effective reuse. Domain analysis has been defined as the process of identifying, collecting, organizing, analyzing and representing a domain of interest based on information available for that domain (Guerrieri 1990). Thus, domain analysis can be applied over the large part of the development process to enhance software productivity and minimize cost without sacrificing quality (Ramesh & Rao 1994). For instance, analysis information and design information can be candidates for reuse using domain analysis. Actually, Coad (1992) offers seven patterns for object-oriented analysis and object-oriented design as well as providing examples and guidelines for applying them.

Basically, a number of technical studies on IS reuse have been undertaken around the object technology over the last decade (El-Rewini & Hamilton 1995). The methods and tools that realistically enable IS reuse based on object concept are being further researched and developed in this area.

2. Non-Technical Factors

Another stream of research has addressed non-technical factors that promote IS reuse (Joos 1994, Fafchamps 1994, Frakes & Isoda 1994). These factors include organization, economics, culture, and law (Prieto-Diaz 1993). Prieto-Diaz (1993) mentions that non-technical problems are as important as technical problems and that they may be more difficult to solve than technical problems. A primary theme of non-technical research area is the need to consider people issue or organizational issue in order to enhance IS reuse level. Most of the early non-technical studies on IS reuse were exploratory in that they focused on identifying the issues and key factors in IS reuse (Prieto-Diaz 1993, Frakes

& Isoda 1994, Fafchamps 1994, Joos 1994). These studies identified factors that could potentially influence the level or maturity of IS reuse. Fafchamps (1994) suggests that successful reuse should begin with a careful understanding of organizational structure and be integrated within the culture of a company's existing organizational structure. Joos (1994) and Frakes and Isoda (1994) recommend that successful reuse implementation require support from top management. Also, many researchers have recognized the importance of IS reuse formality in enhancing IS reuse level across organization (Hudson & Koltun 1991, Prieto-Diaz 1993, Frakes & Fox 1995).

It has been argued that not only does information systems evolve through various stages in organizations (Nolan 1979, McFarlan et al 1983), but IS reuse also evolves through different stages. A variety of models have been developed to categorize IS reuse of the organization based on different characteristics such as reuse breadth, reuse planning and reuse process (Hudson & Koltun 1993, Davis 1993). These reuse characteristics which differ in the various stages are essentially non-technical factors.

IV. Discussion of Organizational Factors to IS Reuse

This section attempts to explain how the organizational characteristics have an effect on the information systems reuse. A number of researchers suggested the effective way of enhancing IS reuse from managerial or organizational point of view (Prieto-Diaz 1993, Joos 1994, Fafchamps 1994, Frakes & Isoda 1994). Mostly they appear to agree with the notion that IS reuse implementation should be undertaken with understanding of organizational climate, structure, and other key contexts of the organization. Effort toward higher level of IS reuse should attend to various issues like those mentioned above. In this single paper, it is very difficult to cover all of the organizational factors of IS reuse. Rather, this study limits its focus to major organizational factors of IS reuse that have been frequently emphasized in IS reuse literature: IS size, industry

type, communication openness among IS employees, reuse climate, IS structure, reuse formality and top management commitment. Literature review of IS reuse suggests that this set of organizational variables seems to be significant in affecting IS reuse. ⟨Table 1⟩ shows the literature support for these organizational variables.

This study argues that bigger IS size, service type of industry, more open communication among IS staff, more positive reuse climate, more centralized IS structure, more formal reuse, and more top management commitment lead to higher level of IS reuse of a firm. It may be argued that there are some interaction effects among organizational factors. Each organizational factor, its importance, and its relationship with IS reuse are explained in the following section.

⟨Table 1⟩ Organizational Factors and Literature Support

Organizational Factors	Literature Support
IS Size	Frakes & Fox (1995), Fafchamps (1994)
Industry Type	Frakes & Fox (1995)
Communication among IS staff	Fafchamps (1994)
Reuse Climate	Joos (1994), Frakes & Fox (1995), Fafchamps (1994)
IS Structure	Fafchamps (1994)
Reuse Formality	Prieto-Diaz (1993), Davis (1993), Hudson & Koltun (1991)
Top Management Commitment	Joos (1994), Fafchamps (1994), Frakes & Isoda (1994)

Information Systems Size. Many researchers have suggested that organizational size is a key determinant of information systems differences across organizations (Ein-Dor & Segev 1978). It can be expected that larger organizations have a greater demand for information and information systems. Also, IS functions tend to be large in such organization. This, in turn, creates greater possibilities and opportunities for IS reuse.

Industry Type. Literature shows that industry type could explain the differences of information systems characteristics of organizations such as IS planning. Frakes and Fox (1995) empirically tested that industry type affected the IS reuse level. However, their study was too narrowly focused to generalize examining only high-technology industry such as telecommunication and aerospace. This study argues that more IS intensive industries such as service industry will have higher IS reuse level than less IS intensive industries like manufacturing industry.

Communication Among IS Staff. Fafchamps (1994) mentions that free exchange of past experiences and lessons of IS reuse among IS staff across the organization is needed in order to enhance the level of reuse. In addition, entire IS staffs have to share reusable parts of information system to increase the organizational level of IS reuse. Thus, communication barriers among IS staff tend to be lower in organizations achieving a higher level of IS reuse. Organizations with better communication among IS personnel will display a higher degree of IS reuse.

Reuse Climate. Psychological climate is defined as attitudes to, perceptions of, and expectations from various events that occur within organization (Ein-Dor & Segev 1978). This claim extends to information systems as well. The company has its own climate for IS reuse, which is formed from the dominant view of IS reuse held by its key members. According to the literature, researchers recognize that reuse climate could be a major factor in promoting organization's reuse level (Joos 1994, Frakes & Fox 1995, Fafchamps 1994).

IS Structure. Information system structure has been discussed mainly with respect to IS strategy. But it also may have relationship with IS reuse. Fafchamps (1994) mentions that the divisional structure (more decentralized structure) effectively facilitates intrateam collaboration but hampers the

cross-team collaboration necessary for organization-wide enhancement of IS reuse. Also, it seems that more centralized IS structure may provide more favorable environment for systematic, widespread reuse. Therefore, more centralized IS structure is expected to have more positive impact on reuse.

Reuse Formality. Researchers have emphasized the need for widespread, systematic reuse for ensuring higher quality and higher level of IS reuse within organizations. Prieto-Diaz (1993) and Frakes and Fox (1995) highlight the importance of planning and performing the reuse process systematically and formally. In their RMM (Reuse Maturity Model) model, Hudson & Koltun (1991) show that this formality is a very important factor in IS reuse.

Top Management Commitment. Recent research indicates that top management commitment plays a very important role in promoting IS reuse (Joos 1994, Fafchamps 1994, Frakes & Isoda 1994). Joos (1994) recommends that any group trying to implement reuse should first obtain or ensure support from top management. Frakes and Isoda (1994) argued that systematic reuse requires long-term management support because it may require years of investment and involve significant changes to management structure.

V. Conclusion

This study involves the identification of a comprehensive set of organizational factors that are related to IS reuse and the discussion of the relationship between organizational attributes and IS reuse. This study suggests that organizational factors are very important and critical to IS reuse. This study could help organizations manage and execute IS development strategy effort related with IS reuse, and hence make better decisions about the allocation of resources to reuse and the direction of their information systems regarding the IS development productivity. Thus, this paper is likely to enhance IS manager's

understanding of how to carry out an effective reuse program and an effective migration strategies to higher productivity stage in their organization.

This study mainly discussed organizational factors out of all non-technical factors to IS reuse enhancement, letting other non-technical factors such as economic, or legal factor to be studied by future researchers. In addition, this study did not exhaust the range of organizational factors that might influence IS reuse. Rather it focused on those that are considered significant based on the literature review. Some of the other candidate factors that might be of interest are: reuse recognition and rewards, prior experience with IS reuse, and training. Therefore, further elaboration and empirical validation on this study could further both managerial and academic understanding of this important area of IS research.

IS reuse and its link to organizational factors have been the subject of considerable interest in the literature. IS reuse cannot be discussed without considering organizational context. While a number of models for information system reuse exist in the literature, this study has suggested that IS reuse should be implemented with a careful understanding of organizational attributes in order to ensure widespread reuse. This study provides meaningful implications for improving our understanding of important relationships between organizational variables and IS reuse, for guiding future research, and for practitioners.

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