A Global Product Lifecycle Management Information System Implementation Case Study: A Framework Integrating PLM, Culture, and Critical Success Factors

by

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Dedication

This research is dedicated to my wife Anne for her constant loving support which made completion of this dissertation possible.

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Abstract

The implementation of global Product Lifecycle Management (PLM) information systems (IS) is a complex and challenging technological and social endeavor. This research explored these difficulties though the holistic analysis of a global PLM information system implementation project conducted by an international company and focused on the following research questions: How does vision of success for global PLM information systems vary by culture? How do goals for global PLM information systems vary by culture? What are the Critical Success Factors (CSFs) for global PLM information systems implementation? How does culture change the relative importance of CSFs for global PLM information systems implementation? What theoretical framework emerges to integrate global PLM information systems implementation, culture, and CSFs?

This mixed-methods case study merged CSFs with grounded theory and progressed through three stages of data collection and analysis: in-depth interviews with the company's PLM steering committee; a survey of the company's project team; and a focus group with the company's steering committee. The six most significant findings were as follows:

1. The differences between PLM CSFs and Enterprise Resource Planning (ERP) CSFs are minimal.
2. There is not one list of CSFs, but rather multiple lists where importance is determined by project phase. Similarly, there is not one type of CSF, but three, which vary in essence: triggering (causal); phase-specific (contextual); and cross-phase (intervening).
3. The rating of CSF importance by project phase proved valuable because CSFs are deterministic lead measures that give leverage to the project team.

4. The study found 22 CSFs with statistically significant differences in importance based on the analysis of variance (ANOVA) by culture. These 22 CSFs represented areas of potential conflict worthy of additional management care.
5. The relationship between engineers and IT associates working on the PLM project was framed as customer / supplier. This segregated power-distance view of information systems implementation is radically different than two equal partners jointly striving towards a mutually agreed common goal and may lead to interactions that are formal, distant, and at "arms-length."
6. The data supported development of a preliminary theoretical framework integrating PLM information systems implementation, culture, and CSFs. The framework merged CSFs with grounded theory producing an integrated closed-loop model applicable to a wide variety of information systems implementation challenges.

The results of this research may yield valuable insights for other organizations faced with the complexity of a global information systems implementation in a multi-cultural environment.

Keywords

Following is a list of keywords associated with this research:

- Computer-Aided Design, Computer Aided Design, CAD
- Computer-Aided Manufacturing, Computer Aided Manufacturing, CAM
- Critical Success Factors, CSF, CSFs
- Culture, Multi-Cultural, Cross-Cultural, National Culture, Professional Culture
- Engineer-to-Order, Engineer to Order, ETO
- Information Systems Implementation, IS Implementation, IS
- Information Technology Implementation, IT Implementation, IT
- New Product Development, NPD, New Product Commercialization, New Product Commercialization Process, NPCP, New Product Development and Introduction, NPDI
- Product Data Management, PDM
- Product Lifecycle Management, Product Life-Cycle Management, PLM
- Project Management

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Chapter 1 Introduction

DMS Global Case

DMS Global (an alias to protect the identity of the company) designed, manufactured, and serviced heavy industry equipment on a global scale. Engineering and manufacturing operations for new products are located in Pennsylvania, United States (US), and in Chiba prefecture, Japan. A network of 31 Global Service locations provided services for the installed base of equipment.

Orders for new products are fulfilled from either the US or Japan depending on the end destination of the equipment, and/or the available capacity in either country. It was not uncommon for a global customer to place multiple orders for the same product to satisfy the same need in different locations around the globe. Similarly, it was not uncommon for DMS Global to satisfy the demand for product on an earlier order from the US, and demand for the same product on a subsequent order from Japan; or vice versa.

When the product arrives at the customer site, however, there were variations not only in the physical characteristics of the equipment, but also in the supporting engineering data and documents, based on whether the order was fulfilled from the US or Japan. Rather than reuse existing designs, DMS Global would reengineer the product even if it was identical, or similar, to a product on another order, increasing lead time and costs. The redesign also allowed for the introduction of errors thus reducing quality. These variations caused problems for DMS Global's customers. These differences also caused difficulty for DMS Global's 31 service centers. The primary root cause was that DMS Global used a heterogeneous mix of engineering information systems (IS) and processes in the US and Japan. Further compounding the problem were the Global Service locations which also had autonomous engineering IS and processes.

In March 2010, with annual revenues approaching 1.1 billion US dollars, DMS Global formed a project team to explore the feasibility of implementing a common company-wide commercial-off-the-shelf Product Lifecycle Management (PLM) IS to serve not only engineering and manufacturing operations in the US and Japan, but also the network of 31 Global Service locations spread across the globe. The internal DMS Global PLM IS implementation project charter stated the problem as follows:

> Information sharing is difficult and inefficient. When jobs are transferred or shared between the United States and Japan, many tasks are repeated in order to satisfy the requirements of each location. Our differences are a barrier to optimizing the engineering's team ability to support the growth objectives of DMS Global. (DMS Global, 2010, p. 8)

The 12-member project team was jointly led by an engineering manager from the US and an engineering manager from Japan and ten representatives from engineering and information technology (IT) from US, Japan, and Global Service locations. The project team had two primary deliverables in 2010:

1. [Identify] Common processes and procedures that would allow DMS Global to share a common PDM [Product Data Management] [information] system.
2. Define [the] requirements for an integrated PDM [information] system [and] identify which system meets DMS Global needs. (DMS Global, 2010, p. 1)

As indicated by the 2010 deliverables, the initial focus was on PDM, a component of PLM that focuses on the core information needed by engineers (Connolly, 2011, pp. 35–36). As the project team defined requirements, however, their scope expanded from PDM to PLM; which focuses on the complete lifecycle of a product, including field service (Cao & Folan, 2012, p. 659).

During the course of 2010, the cross-functional project team arrived at the following vision of success:

> The Engineering Team's vision of success includes common engineering [information] systems, processes and procedures. DMS will have the ability to share information, share resources, share load and the ability to *'Chase The Sun'.* (DMS Global, 2010, p. 1)

The PLM vision was further defined by the following 13 goals:

1. Enable process harmonization between Japan and the US.
2. Replace manual file shares in Japan.
3. Streamline and simplify CAD [Computer Aided Drafting], document, and BOM [Bill of Material] management integration.
4. Improve collaboration with internal and external design partners.
5. Improve/integrate [the] change management process.
6. Support legacy AutoCAD data and provide transition from AutoCAD to ProE, if desired.
7. Allow for a "Bill of Information" that includes quality related requirements with drawings.
8. Manage the full product lifecycle (design, development, test, after market service).
9. Provide a platform to manage and service the install base of industrial equipment.
10. Integrate upstream and downstream processes with engineering data.
11. Increase agility to respond to changes.

12. Lower total cost of ownership by consolidating and simplifying the IT software application framework.
13. Establish a world-class IT application infrastructure to support enterprise growth and reduction of risk. (DMS Global, 2011, p. 10)

Having defined the vision of success and 13 goals, the project team selected “Windchill” from Parametric Technology Corporation (PTC) as the preferred PLM IS. The team received executive approval to begin their PLM IS implementation in July, 2011.

In order to fully understand this decision, it is first necessary to define PLM. Accordingly, the next section focuses on defining PLM and the components and considerations of PLM implementation.

PLM

Products have a life; they are introduced (born), they grow, they mature, and they decline (die) (Heizer & Render, 2014, p. 158). As children have different needs during their stages of development, so do products have different management needs during their stages of development and demise (Heizer & Render, 2014, p. 159). PLM, therefore, at its core is a set of business processes that manage a product’s varying needs through its stages of life. Schuh, Rozenfeld, Assmus, and Zancul (2008) concurred when they defined PLM as, “a concept for the integrated management of product related information through the entire product lifecycle” (p. 210). The entire product lifecycle, however, is not merely a measure of duration, but also a measure of extent, as a product’s life encompasses integration with supply chain partners.

Connolly (2011) understood the need for supply chain integration and offered an expanded description of PLM as, “a business environment for managing product information from initial development to obsolescence,” that includes, “all of the realms of production, such as needs analysis and planning, concept design, analysis, production planning, manufacturing, sales and distribution, customer support and maintenance, business/accounting, and product disposal and reuse" (pp. 35–36). Cao and Folan (2012) took a similarly broad view of the scope of PLM when they noted the product lifecycle involved, "the complete life of a product – from cradle to grave, from product conceptualization, through design, production, sales, customer use and service, to decommissioning" (p. 659). I merged the concepts above into the following succinct working definition of PLM: *a business environment for the integrated management of product related information through the complete lifecycle of a product within the enterprise and across the supply chain.*

PLM IS

Business processes are often automated by IS. Mendel (2011) focused on the IS needed to support the PLM business environment when he observed PLM IS encompass the functionality necessary to automate and integrate engineering, purchasing, manufacturing, and service (p. 42). Likewise, Cantamessa, Montagna, and Neirotti (2012) concentrated on IS when they stated, "product lifecycle management (PLM) systems have provided firms with new tools to support product information management through design, and manufacture, to service and disposal" (p. 191). They also stressed the need for not only cross-functional intra-enterprise integration, but also inter-enterprise integration along the supply chain (Cantamessa et al., 2012, p. 193). Accordingly, this research defined a PLM IS as: *an information system that supports the integrated management of product related information through the complete lifecycle of a product within the enterprise and across the supply chain.* Having defined a PLM IS, the following section discusses the challenges associated with their implementation.

PLM IS Implementation

Schuh et al. (2008) observed, "The promise of PLM has yet to be realized in most organizations" (p. 210). The implementation of PLM IS rarely meets expectations. Schuh et al. (2008) offered three fundamental reasons for the limited results. First, as noted above, PLM is complex and a general understanding of what it means in practice is lacking (Schuh et al., 2008, p. 210). Second, many PLM initiatives do not adopt a holistic approach to the entire product lifecycle but rather focus on isolated functionality such as document management or parts classification (Schuh et al., 2008, p. 210). Third, and finally, Schuh et al. claim, "… there is a research and literature gap regarding PLM information system implementation issues" (p. 210). Cantamessa et al. (2012) agreed that most literature regarding PLM IS was technical in nature and demonstrated, "… a limited understanding of acceptance and use of such technologies in user's work" (p. 192). Finally, Kropsu-Vehkapera, Haapasalo, Harkonen, and Silvola (2009), when researching Product Data Management (PDM), a component of PLM, noted this was a relatively new area of academic research and the literature was scarce (p. 770). The lack of academic literature was unfortunate for DMS Global as they approached their PLM IS implementation.

The realization of the DMS Global PLM vision of success required significant change in enterprise-wide engineering processes, roles, and responsibilities. Brynjolfsson and Hitt (1998) claimed:

> The greatest benefits of computers appear to be realized when computer investment is coupled with other complementary investments; new strategies, new business processes and new organizations all appear to be important in realizing the maximum benefit of IT. This change is rarely easy since many organizations will require a painful and time

consuming period of reengineering, restructuring and organizational redesign in order to best utilize their IT investments. (p. 3)

As the PLM project team began to understand the full magnitude of change required, progress slowed and realization of the PLM vision was threatened. The resistance was driven in part by the disruption inherent in the process and in part by the organizational change required to migrate from a myriad of disintegrated legacy systems to a common PLM application platform. Changes to processes and organizational structures, however, were only the tip of the iceberg.

Culture

Holland and Light (1999) observed, "Legacy systems encapsulate the existing business process, organization structure, culture, and information technology" (p. 31). Migrating to a new system changes not only processes, structures, and technology, but also culture. Like an iceberg whose primary mass lies below the surface, so to the primary mass of IS change lies below the surface. On the surface, a single integrated global PLM IS required DMS Global to change processes, organizational structures, and information technology. On a deeper, more fundamental level, one world-wide integrated PLM IS required DMS Global to change its culture.

Gaspay, Dardan, and Legorreta (2008) observed that the concept of culture originated in the field of anthropology and is based on the work of seminal researchers such as Hall, Kluckhohn and Strodtbeck, Trompenaars and Hampden-Turner, Schwartz, and Hofstede (p. 3). After providing a brief summary of the contributions of the key cultural researchers above, Gaspay et al. (2008) note, Hofstede's cultural framework is the most widely used in IT research (p. 4). Therefore, I chose to use Hofstede's model was used in this research.

Hofstede, Hofstede, and Minkov (2010) defined culture as "the collective programming of the mind that distinguished the members of one group or category of people from others" (Hofstede et al., 2010, p. 6). The collective programming of the mind (mental models) embodies learned patterns of thinking, feeling, and acting (Hofstede et al., 2010, p. 8).

Culture and IS Implementation

For the DMS Global PLM IS to achieve its vision of success (common engineering systems, processes and procedures across geographies), and to improve integration and productivity, people across the DMS Global enterprise were required to think, feel, and act differently than they do with today's current systems, processes and procedures (Brynjolfsson & Hitt, 1998, p. 3). DMS would need to find a way to span, or narrow, their cultural gaps. To this end, Early (2006) recommended research move away from value surveys towards development of theories and frameworks that explain the action / interaction among culture, perceptions, organization, and structures (p. 928). Such a framework would be helpful to DMS Global. What cultural frameworks exist to assist IS implementations?

Hofstede et al. (2010) claimed national culture was multi-layered and comprised of symbols, heroes, rituals, and values (see Figure 2 below) (p. 8). The first three layers, visible to the external observer, were collectively termed practices (Hofstede et al., 2010, p. 9). The inner core of values, typically learned by age ten, represented broad tendencies or feelings to prefer one state of affairs over another (Hofstede et al., 2010, p. 9). The cultural depth of change required to realize the DMS Global PLM IS was significant, diving below the level of practices down to the level of long-held core values.

The primary levels of culture affecting the DMS Global PLM IS implementation are national (US and Japanese) and professional (engineering and IT). A secondary level of culture associated with the DMS Global PLM project is organizational (management and professional). Hofstede et al. (2010), however, caution that management culture should not be viewed in isolation from national societies (p. 25).

Culture and PLM IS Implementation

The implementation of a PLM IS is a complex and challenging endeavor. When multiple cultures are involved, complexity and challenge grow. Faced with the daunting challenges of implementing a common enterprise-wide PLM IS, growing resistance to change aggravated in part by the existence of multiple cultures, and a paucity of literature from which to draw practical implementation advice, how could DMS Global best proceed? How could they address the problem posed by disparate legacy systems and realize the PLM project vision of common engineering systems, processes, and procedures that would allow DMS Global to share information, share resources, share load, and “chase the sun?” What could DMS Global do, when confronted with these broad and deep issues, to focus their limited resources on the aspects of the PLM project most likely to assure success? What were the Critical Success Factors (CSFs) for a global PLM IS implementation?

CSFs

Daniel (1961) first introduced the term *success factors* into the management literature in 1961 (p. 116). He began his Harvard Business Review article titled “Management Information Crisis” with three vignettes of companies who were struggling to make management decisions because they lacked quality information (Daniel, 1961, p. 111). He observed, “In retrospect it is obvious that these three companies were plagued by a common problem: inadequate management information. The data were inadequate, not in the sense of there not being enough, but in terms of relevancy for setting objectives, for shaping alternative strategies, for making decisions, and for measuring results against planned goals" (Daniel, 1961, p. 111).

Daniel was fearful the response to the management information crisis would be a marked increase in the quantity and detail of information. He cautioned, "Excessive detail is the quicksand of intelligent planning" (Daniel, 1961, p. 119). Others shared Daniel's concern. He noted, "In many organizations the initial reaction to the management information problem is first evidenced by a concern over 'the flood of paper work.' Eventually, the problem itself is recognized – i.e., the need to define concisely the information required for intelligent planning and control of a business" (Daniel, 1961, p. 119). To avoid an "information flood," Daniel (1961) advised, "… a company's information system must be discriminating and selective. It should focus on 'success factors.' In most industries there are usually three to six factors that determine success; these key jobs must be done exceedingly well for a company to be successful" (p. 116).

Eighteen years after Daniel's article, the problem of inadequate information remained. Rockart (1979) described the difficulty as, "Once one gets above the functional level, there is a wide variety of information that one might possibly need, and each functional specialty has an interest in 'feeding' particular data to a general manager…. a massive information flow occurs" (p. 81). There was a problem defining concisely what information senior manager's required (Rockart, 1979, p. 82).

Rockart (1979) provided an analysis of the four current approaches to determining managerial information needs (i.e. by-product technique, null approach, key indicator system, and total study process), and then he proposed a new "superior methodology" to elicit CSFs from chief executives (pp. 82–85). His methodology involved two, and sometimes three, interviews with the chief executive to define: goals; CSFs supporting the goals; measure supporting the CSFs; and information supporting the measures (Rockart, 1979, p. 85). He defined CSFs as, “the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organization. CSFs are the few key areas where ‘things must go right;’ for the business to flourish” (Rockart, 1979, p. 85).

CSFs and IS Implementation

In 1979, Rockart (1979) predicted broader applications of his CSF method when he noted, “The CSF concept itself is useful for more than information system design” (p. 88). Looking back over the history of CSFs, Cooper (2009) observed,

> Since its initial inception, the CSF method has been adapted and extended to meet the needs of a wide range of research projects including: extensions to the domain and industries of applications; adaptations to the techniques used to elicit CSFs; and extensions to ways in which the results of CSF studies are presented. (p. 12)

Cooper (2009) continues, “Much research has been conducted in IS in order to understand the key factors that enable organizational and more specifically, IS success” (2009, p. 9).

CSFs were identified for Customer Relationship Management (CRM) by Rahimi and Berman (2009) as well as Croteau and Li (2003). Similarly, Siemieuniuch and Sinclare (2004) found 14 factors that help ensure that an organization is ready for Knowledge Lifecycle Management (pp. 87–14). Likewise, Tan, Cater-Steel, and Toleman (2009) document six CSFs necessary for the implementation of the Information Technology Infrastructure Library (ITIL). The majority of the CSF IS related research, however, has focused on Enterprise Resource Planning Systems (ERP). Perhaps CSFs would provide a useful framework to guide the PLM IS implementation in multi-cultural environments.

CSFs and PLM IS Implementation

While a relatively large body of knowledge exists regarding ERP system implementations, Cantamessa et al. (2012) claimed this literature may not be directly applicable to PLM IS implementation, given two fundamental differences between ERP and PLM IS (p. 192). They observed:

1. PLM technologies are less prescriptive over the ways in which tasks must be accomplished. Their use at the individual level is thus partially voluntary, as use of some features provided by the system are not compulsory for accomplishing some tasks in engineering and design jobs.
2. PLM is not intended to support routine and short-lived transaction-oriented processes. With respect to most other business processes, NPD [New Product Development] is inherently less predictable, of significantly longer duration, and more knowledge-intensive (often depending on tacit knowledge), and it involves very large teams that must cooperate across both the company and its supply chain. (p. 192)

Perhaps Rockart's CSF method would overcome these two differences.

Soliman, Clegg, and Tantoush (2001)focused on the integration of CAD/CAM (Computer Aided Design/Computer Aided Manufacturing), a technological component supporting PLM, and ERP. They recommended using CSFs to not only focus limited management attention, but also to help assure project success (Soliman et al., 2001, p. 615). They noted, "… there appears to be some confidence and support for obtaining CSF for integration of CAD/CAM systems with ERP systems" (Soliman et al., 2001, p. 615). Using grounded theory investigation and a panel of experts, Soliman et al., (2001) developed the following eight CSF for the integration of CAD/CAM and ERP systems (pp. 617–618):

1. CAD/CAM user's appreciation of integration;
2. Communication between design office and other users;
3. Design office services and support functions;
4. Management commitment and support;
5. Organizational effectiveness;
6. Training of CAD/CAM staff on ERP system;
7. Security of CAD/CAM interface; and
8. User friendliness of ERP systems.

Beyond the study by Soliman et al., (2001), I found no other academic literature related to CSFs for PLM IS implementation. This is not surprising given Schuh, Rozenfeld, Assmus, and Zancul's (2008) claim, "there is a research and literature gap regarding PLM information system implementation issues" (p. 210).

Problem Statement

DMS Global, like other multinational engineer-to-order firms, was faced with the challenge of automating engineering business processes in a manner that improved integration and productivity. In response to this challenge, DMS Global launched a multi-year project to implement an enterprise-wide commercial off-the-shelf PLM IS. The cross-functional, cross-cultural project team established a broad and compelling vision of success, and then added depth to the vision by documenting 13 discrete goals to be realized.

Their scope included the internal value chain and collaboration with external supply chain partners. When fully implemented, their PLM IS would support integrated management of product related information through the complete lifecycle of a product – within the enterprise, and across the supply chain. As the magnitude of change required to achieve the vision permeated the project team, progress slowed and the PLM vision was put in jeopardy. A single integrated global PLM IS required not only new business processes and information technology, but also new ways of thinking, feeling and acting. In essence, PLM required a new culture (Hofstede et al., 2010, p. 8).

In and of itself, the implementation of a PLM IS was a complex and challenging technological and social endeavor. For DMS Global, the complexity and challenge of the global PLM IS implementation was further compounded by the presence of multiple cultures. The academic literature was largely silent offering little empirical or theoretical help to multinational engineer-to-order firms seeking to implement a common enterprise-wide PLM IS. To state the problem succinctly, there was no theoretical framework integrating global PLM IS implementations, culture, and CSFs.

Purpose of the Study

The purpose of this research was twofold. The primary purpose was to explore the challenges associated with global PLM IS implementations through the holistic analysis of the single instrumental DMS Global case (Creswell, 2007, p. 74, 75). The secondary aim was to develop a preliminary theoretical framework that modeled the process of implementing a global PLM IS in an engineer-to-order multi-cultural environment similar to DMS Global.

Early (2006) recommended, "…scholars refocus their attention away from any more of these values surveys and toward developing theories and frameworks for understanding the linkages among culture, perceptions, actions, organizations, structures, etc." (p. 928). The theoretical framework will be preliminary and will require further research to validate.

The idea of a theoretical framework arose from Strauss and Corbin (1990). The first occurrence was in relation to analysis of data. They observed:

> Insight and understanding about a phenomenon increase as you interact with your data. This comes from collecting and asking questions about the data, making comparisons, thinking about what you see, making hypothesis, developing small theoretical frameworks (miniframeworks) about concepts and their relationships. (Strauss & Corbin, 1990, p. 43)

Later, when discussing the development of a conditional matrix they noted:

> What we want to do here, essentially, is to provide you with a framework that summarizes and integrates all we have presented previously … here we want to make the linkage very explicit and tie our method of analysis together to form an explanatory framework. (pp. 158–159)

Hence a theoretical framework summarizes, integrates, and explains the action / interaction related to a phenomenon.

Research Questions

The lack of a theoretical framework integrating global PLM IS implementations, culture, and CSFs led to the formation of the following research questions:

RQ1: How does vision of success for global PLM IS vary by culture?

RQ2: How do goals for global PLM IS vary by culture?

RQ3: What are the CSFs for global PLM IS implementation?

RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation?

RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs?

The research questions were rooted in a review of the literature (Appendix H).

Brief Methodology

To answer the research questions, this case study research employed mixed methods and progressed through three-stages of data collection and analysis as pictured in Figure 1.

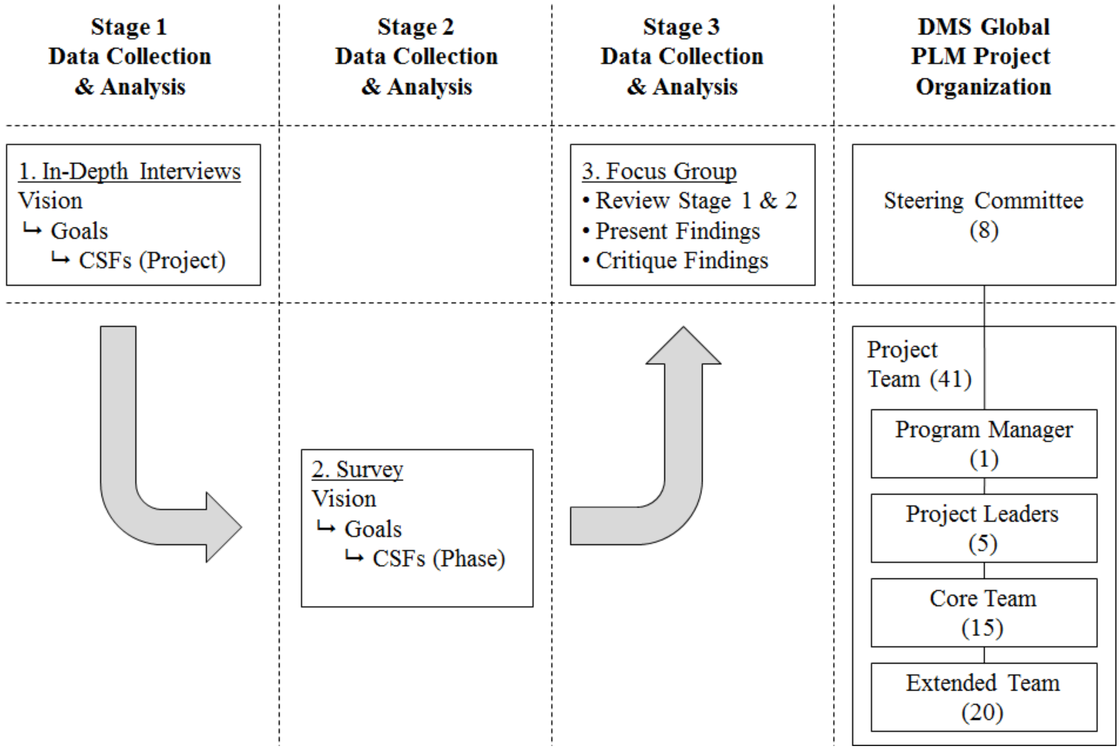

Figure 1. Research Design – Case Study with Mixed Methods

Chapter 1 Introduction Summary

DMS Global, a multinational designer, manufacturer, and servicer of engineer-to-order heavy industrial equipment had disparate engineering IS and processes that created a barrier to enterprise growth. In response, the firm launched a multi-year project in 2010 to implement a common enterprise-wide PLM IS. The cross-functional cross-cultural project team established a broad and compelling vision of success and then added depth to the vision by documenting 13 discrete goals to be realized. As the project team began to understand the magnitude of change required to achieve the vision, progress slowed and realization of the PLM vision was threatened.

A single integrated global PLM IS required not only new business processes and information technology, but also new ways of thinking, feeling and acting. In essence, PLM required a new culture (Hofstede et al., 2010, p. 8). Unfortunately, the academic literature was largely silent and offered little empirical or theoretical help. The problem was the lack of a theoretical framework integrating global PLM IS implementations, culture, and CSFs.

The purpose of this research was to conduct a case study of the DMS Global PLM IS implementation and to develop a preliminary theoretical framework that modeled the process of implementing a PLM IS in an engineer-to-order multi-cultural environment similar to DMS Global. This research employed the mixed methods of: in-depth interviews, a quantitative survey, and focus groups to answer its five research questions.

Chapter 2 Literature Review

Introduction

The literature review formed a symbiotic relationship with the problem statement, purpose of the study, methodology, and research questions. The problem, purpose, methodology, and research questions not only guided and directed the literature review, but also were reciprocally focused and refined by the literature review. The problem statement may be summarized as the lack of a theoretical framework integrating global PLM IS implementations, culture, and CSFs. In response, the two-fold purpose of the case study was to explore the challenges associated with global PLM IS implementations and to develop a theoretical framework that models the process of implementing a global PLM IS in an engineer-to-order multi-cultural environment similar to DMS Global. To realize the purpose, the study employed mixed methods and progressed through three-stages of data collection with Rockart's (1979) CSF method as the theoretical framework augmented by grounded theory methods from Strauss and Corbin (1990, 1998). The methodology gathered and analyzed data related to five research questions; all of which were linked to the problem – the lack of a theoretical framework integrating PLM IS implementation, culture, and CSFs.

Purpose

The purpose of the literature review was three-fold. First was to raise my level of theoretical sensitivity; "the ability to respond to the subtle nuances of, and clues to, meaning in data" (Strauss & Corbin, 1998, p. 35). Second was to discover knowledge gaps in the domains of PLM IS implementation, culture, and CSFs. Creswell (2007) observed, "the literature review in grounded theory shows gaps or bias in existing knowledge, thus providing a rationale for this type of qualitative study. (p. 190). Third, and finally, was to identify methods from the literature that could be applied to the DMS Global case study.

Strauss and Corbin (1990) provided additional guidance for the literature review when they listed the following five uses of academic literature in grounded theory research:

1. The literature can be used to stimulate theoretical sensitivity by providing concepts and relationships that are checked out against actual data. Though you do not want to enter the field with an entire list of concepts and relationships, some may turn up over and over again in the literature and thus appear to be significant. These you may want to bring to the field where you will look for evidence of whether or not the concepts and relationships apply to the situation that you are studying, and if so what form they take.
2. The literature can be used as secondary sources of data…. In fact, one form of qualitative research is the analysis of theoretical or philosophical statements and writings per se.
3. It can stimulate questions. You can use the literature to derive a list of questions you want to ask your respondents or to guide your initial observations.
4. It can direct theoretical sampling. The literature can give you ideas where you might go to uncover phenomena important to the development of your theory. In other words, it can direct you to situations that you may not otherwise have thought of, but that are similar or different from those being studies; thereby enabling you to add variation to the study.

5. It can be used as supplementary validation. When you have finished developing your theory and are writing up your findings, you can reference the literature in appropriate places to give validation of the accuracy of your findings. (1990, pp. 50–52)

The guidance from Strauss and Corbin (1990) combined with the three-fold purpose governed the organization of the literature review.

Organization

Three domains emerged from the problem statement: PLM IS implementation, culture, and CSFs. Therefore it was necessary for the literature review to explore all three. I chose to address all three domains respectively, in a broad-to-narrow fashion.

Each domain began with an introduction which described the organization and flow. Following the introduction, the domain topic was defined in broad general terms. From the general definition of the domain, the scope was narrowed to the domain and IS implementation. The review continued with an even tighter focus on the domain and PLM IS implementation. The domain concluded with a summary. For example, the portion of the literature review related to culture began with introduction which described the broad-to-narrow flow, continued by defining culture in broad general terms, narrowed the scope to consider culture and IS implementation, carried on with a tight focus on culture and PLM IS implementation, and concluded with a summary.

As the literature review proceeded through each domain in a broad-to-narrow manner, I noted where the literature prompted the formation of research questions. For example, Schuh et al. (2008) observed, “The promise of PLM has yet to be realized in most organizations” (p. 210). This observation inspired the following research question:

RQ3: What are the CSFs for global PLM IS implementation?

In addition to noting the origin of research questions within the course of the literature review, I provided a consolidated summary of the links between the literature and research questions in Appendix H (Trace Matrix for Research Questions).

The literature review begins with PLM. Given the scarcity of academic literature (Schuh et al., 2008, p. 210; Kropsu-Vehkapera et al., 2009, p. 770) this portion of the literature review is small compared to the section regarding CSFs. Similarly, culture was not the primary focus of this study. Rather, culture served mainly as a stratification factor for data analysis. Accordingly, the cultural portion of the literature review was abbreviated. Conversely, the primary focus of the literature review was Rockart's (1979) CSF method, and its evolution and expansion during the past 35 years, because CSFs provided the theoretical underpinning of the methodology. Accordingly, the bulk of the literature review examined the rich history of CSFs.

PLM Literature Review

PLM.

Products have a lifecycle; they are introduced (born), they grow, they mature, and they decline (die) (Heizer & Render, 2014, p. 158). As children have different needs during their stages of development, so too products have different management needs during their lifecycle (Heizer & Render, 2014, p. 159). Heizer and Render (2014) divided the product lifecycle into four phases as follows:

1. Introductory Phase: products are being fine-tuned for the market and warrant unusual expenditures for research, product development, process modification and enhancement, and supplier development.
2. Growth Phase: product design stabilizes and accurate forecasting for demand and capacity management becomes critical.

3. Maturity Phase: competitors are established necessitating improved cost control and/or additional innovation to maintain growth.
4. Decline Phase: products are now near their end of life and further investment may no longer be warranted. (p. 159)

Orcik, Anisic, Gecevska, and Veza (2012) added four phases before the introductory (product launch) phase as follows:

1. Opportunity Identification and Selection
2. Concept Generation
3. Concept Evaluation
4. Development (2012, p. 373)

PLM, therefore, at its core is a set of business processes that manage a product's varying needs through its stages of life. Schuh et al. (2008) concurred when they defined PLM as, "a concept for the integrated management of product related information through the entire product lifecycle" (p. 210). The entire product lifecycle, however, is not merely a measure of duration, but also a measure of extent, as a product's life encompasses integration with supply chain partners.

Connolly (2011) understood the need for supply chain integration and offered an expanded description of PLM as, "a business environment for managing product information from initial development to obsolescence," that includes, "all of the realms of production, such as needs analysis and planning, concept design, analysis, production planning, manufacturing, sales and distribution, customer support and maintenance, business/accounting, and product disposal and reuse" (pp. 35–36). Cao and Folan (2012) took a similarly broad view of the scope of PLM when they noted the product lifecycle involved, "the complete life of a product – from cradle to grave, from product conceptualization, through design, production, sales, customer use and service, to decommissioning" (p. 659).

I merged the concepts above into the following succinct working definition of PLM: *a business environment for the integrated management of product related information through the complete lifecycle of a product within the enterprise and across the supply chain.*

PLM IS.

Business processes are often automated and integrated by IS. Mendel (2011) focused on the IS needed to support the PLM business environment when he observed PLM IS encompass the functionality necessary to automate and integrate engineering, purchasing, manufacturing, and service (p. 42). Orcik et al. (2012) described PLM IS as a strategic element in IT enterprise architecture that added value by, "converting manually managed processes into automated processes" (p. 375, 377). Likewise, Cantamessa et al. (2012) concentrated on IS when they stated, "product lifecycle management (PLM) systems have provided firms with new tools to support product information management through design, and manufacture, to service and disposal" (p. 191).

Cantamessa et al. (2012) also stressed the need for not only cross-functional intra-enterprise integration, but also inter-enterprise integration along the supply chain (p. 193). Zheng, McMahon, Li, Ding, and Jamshidi (2008) echoed the need for collaboration with supply chain partners when they noted:

> Product lifecycle management (PLM) is the most important systematic strategy and enabling technique to realize this emerging paradigm shift in the manufacturing industry. PLM is a strategic business approach that applies a consistent set of business solutions in support of the collaborative creation, management, dissemination, and use of product

> definition information across an extended enterprise. The approach is applied from concept to the end of life and it integrates people, processes, business systems, and information. (p. 989)

PLM IS are umbrella solutions that integrate the tools required to manage a product through its lifecycle phases (Heizer & Render, 2014, p. 172). Siller, Estruch, Vila, Abellan, and Romero (2008) defined PLM IS as:

> Groupware technologies used for the storage, organization and sharing of product-related data and for the coordination of the activities of a distributed team in the deployment of all products' lifecycle processes like project and portfolio management, product design, manufacturing planning and process design, supply production, client service, recycling and all related activities. (2008, p. 693)

They note that PLM IS evolved from Product Data Management Systems (PDM) (Siller et al., 2008, p. 693).

Philpotts (1996) described PDM as software that helps engineers manage product data, by offering functionality related to data vault and document management; workflow and process management; product structure management; classification; and program management (p. 11,13). Connolly (2011), agreed and defined PDM as, "the aspect of PLM that specifically focuses on the development of the product (design, test, manufacture) which provides the core information needed by engineers, suppliers, and production personnel" (p. 36). Haydaya and Marchildon (2012) identified CAD, software used to create virtual geometric product models, as a core component of PDM (p. 562).

Integrated PLM IS appeared in the late 1990s in response to the need to broaden the scope of PDM beyond engineering (Haydaya & Marchildon, 2012, p. 562). Hu, Wang and Bidanda (2006) also noted the transition from PDM to PLM when they stated:

> The concept of Product Lifecycle Management (PLM) was derived from Product Data Management (PDM) and extends PDM towards a comprehensive approach for product related information and knowledge management within an enterprise. (para. 5)

Connolly (2011) adopted an expansive view of PLM as, "a business environment for managing product information from initial development to obsolescence" (p. 35). Gecevska, Anisic, and Chiabert (2011) had a similarly all-encompassing interpretation of PLM IS which included, "the processes of portfolio management, product design, process design, supply, production. Launch, service, and recycle" (p. 21). Kajmakoska, Lombardi, Chiabert, Anisic, and Gecevska (2012) described PLM as extending from the initial idea through retirement of the product (2012, p. 41).

Accordingly, PLM IS are both cross-functional and inter-enterprise information platforms. Siller et al. (2008) provided the following list of nine capabilities required in PLM IS to meet the diverse needs of its broad base of users:

1. A. Product data vault and document management.

   This is the core functionality of the system and it offers a secure, controlled storage for all the data and meta-data (attributes for the product data).

2. Product data and structure management.

   According to Van den Hamer and Lepoter (1996), the management of product data can be divided into five orthogonal dimensions: Versions, views, hierarchies, status and variants. Each dimension plays an important role in the product structure data management, like carry[ing] out the iterative nature of product design, the representation of different detail levels, the division into assemblies, sub-assemblies and parts, and so forth.

3. Data classification and retrieval.

   These functions make it possible to define attributes for the product data. Authorised users can perform searches that use these metadata for information retrieval.

4. Notifications.

   These are essential for enabling the collaborative environment in which the users can be notified about tasks and engineering changes. Communication can be possible with the system's messaging functions or with interfaced external e-mail applications.

5. Data sharing.

   This function allows authorised users to extract documents from the vault so that they can work with them in their private workspace. Once the tasks or modifications have been completed, the documents can be uploaded back to the shared data vault to make changes visible to other users.

6. Data exchange.

   This is essential when working in a heterogeneous environment where different applications generate files in different formats. Here it becomes necessary to use of standardized formats to represent CAD models, such as STEP and IGES (Initial Graphics Exchange Specification), and to represent other documents.

7. Pre-visualisation.

   This function enables global access and allows the user to pre-visualise CAD documents with the help of Web-based light-weight applications, that lately use file formats like VRML, X3D, JT Open and U3D among other open XML enabled 3D file formats (Subrahmanian et al. 2005).

8. Lifecycle Management.

   This functionality allows the possibility to define lifecycle for documents and rules for transitions between product development stages. Also provides the possibilities to track the document history and to access control according to lifecycle stage.

9. Process management.

   This capability allows defining and monitoring processes like engineering changes and approval processes. The processes must be modeled as workflows (concept to be approached later in this paper), including all necessary actions or steps, and the resources and information required to perform them. PLM tools must have an embedded workflow engine that launch and monitor its execution. (pp. 693–649)

Given the foregoing review of the PLM IS literature, the following working definition of PLM IS was adopted for this research: *an information system that supports the integrated management of product related information through the complete lifecycle of a product within the enterprise and across the supply chain.*

Having defined a PLM IS, the following section discusses the challenges associated with their implementation.

PLM IS implementation.

Soliman et al., (2001) note the benefit of CAD/CAM systems include reductions in cost, reductions in cycle time, reductions in machining time, and improved information flow (p. 610). For companies employing ERP systems, further productivity gains are realized by the integration of CAD/CAM and ERP systems (Soliman et al., 2001, p. 612). The integration of CAD/CAM and ERP in 2001 was a challenging undertaking (Soliman et al., 2001, p. 612). Accordingly, Soliman et al., (2001) recommended using CSFs to not only focus limited management attention, but also to help assure project success noting "there appears to be some confidence and support for obtaining CSF for integration of CAD/CAM systems with ERP systems" (p. 615). Using grounded theory techniques and a panel of experts, Soliman et al., (2001) developed the following eight CSF for the integration of CAD/CAM and ERP systems:

1. CAD/CAM user's appreciation of integration;
2. Communication between design office and other users;
3. Design office services and support functions;
4. Management commitment and support;
5. Organizational effectiveness;
6. Training of CAD/CAM staff on ERP system;
7. Security of CAD/CAM interface; and
8. User friendliness of ERP systems. (pp. 617–618)

Soliman et al., (2001) were not only the first to employ Rockart's (1979) CSF method as the theoretical framework for their PLM IS research, but also were the first to merge grounded theory methods in their study. Their approach informed the methodology for my research and raised the following research questions:

RQ3: What are the CSFs for global PLM IS implementation?

RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation?

RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs?

Smith (2004) explored the justification of a PLM IS implementation through an empirical study (p. 513). Key findings were PDM systems are extremely important with smaller firms choosing less expensive, interfaced web-based applications having limited functionality, and global organizations with more complex design integration challenges opted to implement commercial off-the-shelf fully integrated PDM/PLM applications (Smith, 2004, p. 524). The observations of Smith (2004) stimulated the following research questions:

RQ1: How does vision of success for global PLM IS vary by culture?

RQ2: How do goals for global PLM IS vary by culture?

RQ3: What are the CSFs for global PLM IS implementation?

Laurindo and Carvalho (2005) acknowledged the problems associated with IS and their ability to drive efficiency gains in new product development (NPD) (p. 314). They suggested Rockart's (1979) CSF method, among others, as a theoretical model to be used to assess the effectiveness of IS related to NPD (Laurindo & Carvalho, 2005, p. 314,316). This suggestion prompted the following research question:

RQ3: What are the CSFs for global PLM IS implementation?

Lin, Hui-Jen, and Ming-Yi (2006) also conducted an empirical study of PLM IS implementation (p. 117). A random sample of Taiwan Semiconductor Industry Association IS Managers were interviewed, then data was statistically analyzed using the software application SPSS (W.-T. Lin et al., 2006, p. 120). The three key recommendations emerging from the management interviews were:

1. It is better to implement PDM before ERP.
2. Intra-company systems should be implemented before inter-company systems.

3. Enterprises should incorporate the ideas of knowledge management into ERP and PDM in order to design processes that integrate closely with culture and positive learning. (W.-T. Lin et al., 2006, p. 130)

The statistical approach taken by Lin et al. (2006) not only suggested a quantitative survey be considered as a component of the methodology, but also inspired the following research questions:

RQ3: What are the CSFs for global PLM IS implementation?

RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation?

Schuh et al. (2008) observed, "The promise of PLM has yet to be realized in most organizations" (p. 210). The implementation of PLM IS rarely meets expectations. Schuh et al. (2008) offered three fundamental reasons for the limited results. First, as noted above, PLM is complex and a general understanding of what it means in practice is lacking (Schuh et al., 2008, p. 210). Second, many PLM initiatives do not adopt a holistic approach to the entire product lifecycle but rather focus on isolated functionality such as document management or parts classification (Schuh et al., 2008, p. 210). Third, and finally, Schuh et al. (2008) claimed, "… there is a research and literature gap regarding PLM information system implementation issues" (p. 210). The observations of Schuh et al. (2008) led to the following research questions:

RQ3: What are the CSFs for global PLM IS implementation?

RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs?

Kropsu-Vehkapera (2009) et al., examined PDM practices in four large high-tech companies (p. 758). Their methodology began by defining a PDM framework to aid analysis followed by qualitative interviews (p. 761). Key findings were the overall PDM activities were similar across the four companies in the study, however, the realization, or implementation, of these activities varied based on company background, or culture, and organizational status (Kropsu-Vehkapera et al., 2009, p. 770). The work of Kropsu-Vehkapera (2009) suggested in-depth interviews for the methodology and led to the following research questions:

RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation?

RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs?

Cantamessa et al. (2012) agreed that most literature regarding PLM IS was technical in nature and demonstrated, "… a limited understanding of acceptance and use of such technologies in user's work" (p. 192). Finally, Kropsu-Vehkapera, Haapasalo, Harkonen, and Silvola (2009), when researching PDM, a component of PLM, noted this was a relatively new area of academic research and the literature was scarce (p. 770). The comments of Cantamessa et al. (2012) and Kropsu-Vehkapera et al. (2009) gave support to the following research questions:

RQ3: What are the CSFs for global PLM IS implementation?

RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs?

Having considered the challenges associated with PLM IS implementation, the following section summarizes the PLM literature review.

PLM literature review summary.

The realization of the DMS Global PLM vision of success required significant change in enterprise-wide engineering processes, roles, and responsibilities. Brynjolfsson and Hitt (1998) claimed:

> The greatest benefits of computers appear to be realized when computer investment is coupled with other complementary investments; new strategies, new business processes and new organizations all appear to be important in realizing the maximum benefit of IT. This change is rarely easy since many organizations will require a painful and time consuming period of reengineering, restructuring and organizational redesign in order to best utilize their IT investments. (p. 3)

Their remarks foreshadowed a cultural dimension to PLM IS implementation which materialized when the DMS Global project team began to understand the full magnitude of change required. As a result, progress slowed and realization of the PLM vision was threatened. The resistance was driven in part by the disruption inherent in the implementation process and in part by the organizational change required to migrate from a myriad of disintegrated legacy systems to a common PLM application platform. Changes to processes and organizational structures, however, were only the tip of the iceberg. Below the surface lay the critical mass of culture change.

Culture Literature Review

Culture.

Holland and Light (1999) observed, “Legacy systems encapsulate the existing business process, organization structure, culture, and information technology” (p. 31). Migrating to a new system changes not only processes, structures, and technology, but also culture. Like an iceberg whose primary mass lies below the surface, so to the primary mass of IS change lies below the surface. On the surface, a single integrated global PLM IS required DMS Global change processes, organizational structures, and information technology. On a deeper, more fundamental level, one world-wide integrated PLM IS required DMS Global change its culture. The culture change associated with the DMS Global PLM project supports the five research questions guiding this study.

Gaspay et al. (2008) observed that the concept of culture originated in the field of anthropology and is based on the work of seminal researchers such as Hall, Kluckhohn and Strodtbeck, Trompenaars and Hampden-Turner, Schwartz, and Hofstede (p. 3). After providing a brief summary of the contributions of the key cultural researchers above, Gaspay et al. (2008) note, Hofstede's cultural framework is the most widely used in IT research (p. 4). Terlutter, Diehl and Mueller (2006) concurred and stated, "Without question, Hofstede (1980, 2010) has developed by far the most influential cultural framework…" (p. 423).

The Hofstede et al. (2010) framework measures the differences and similarities of people from varying backgrounds along five cultural dimensions:

1. Power Distance Index (PDI):

   > Power distance can therefore be defined as the extent to which the less powerful members of institutions and organizations within a country expect and accept that power is distributed unequally. (Hofstede et al., 2010, p. 61)

2. Individualism (IDV): *Individualism vs. Collectivism:*

   > Individualism pertains to societies in which the ties between individuals are loose: everyone is expected to look after him- or herself in his or her immediate family. Collectivism as its opposite pertains to societies in which people from birth

> onward are integrated into strong, cohesive in-groups, which throughout people's lifetime continue to protect them in exchange for unquestioning loyalty. (Hofstede et al., 2010, p. 92)

3. Masculinity (MAS): *Masculinity vs. Femininity:*

> A society is called masculine when emotional gender roles are clearly distinct: men are supposed to be assertive, tough, and focused on material success, whereas women are supposed to be more modest, tender, and concerned with the quality of life. A society is called feminine when emotional gender roles overlap both men and women are supposed to be modest, tender, and concerned with quality of life. (Hofstede et al., 2010, p. 140)

4. Uncertainty Avoidance Index (UAI):

> Uncertainty avoidance can therefore be defined as the extent to which the members of a culture feel threatened by ambiguous or unknown situations. (Hofstede et al., 2010, p. 191)

5. Long-Term Orientation: (LTO) *Long-Term Orientation and Short-Term Orientation:*

> Long-term orientation stands for the fostering of virtues oriented towards future rewards – in particular, perseverance and thrift. Its opposite pole, short-term orientation, stands for the fostering of virtues related to the past and present – in particular, respect for tradition, preservatives 'face,' and fulfilling societal obligations. (Hofstede et al., 2010, p. 239)

Hofstede's et al. framing of culture gave rise to the following research questions:

RQ1: How does vision of success for global PLM IS vary by culture?

RQ2: How do goals for global PLM IS vary by culture?

RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation?

RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs?

In 2004, the GLOBE (Global Leadership and Organizational Behavior Effectiveness) study substantiated Hofstede's et al. (2010) five cultural dimensions and extended them to nine (Kummer et al., 2012, pp. 318–319). The nine cultural dimensions of GLOBE were:

1. Power Distance: The degree to which members of an organization or society expect and agree that power should be shared unequally.
2. Uncertainty Avoidance: The extent to which members of collectives seek orderliness, consistency, structure, formalized procedures, and laws to cover situations in their daily lives.
3. Institutional Collectivism: The level at which a society values and rewards "collective action and resource distribution.
4. In-Group Collectivism: The level at which a society values cohesiveness, loyalty, and pride, in their families and organizations.
5. Humane Orientation: The ideas, values, and prescriptions for behavior associated with the dimension of culture at which a society values and rewards altruism, caring, fairness, friendliness, generosity, and kindness.
6. Performance Orientation: The level at which a society values and rewards individual performance and excellence.
7. Assertiveness: A set of social skills or a style of responding amenable to training or as a facet of personality.

8. Gender Egalitarianism: The level at which a society values gender equality and lessens role-differences based gender.
9. Future Orientation: The extent to which members of a society or an organization believe that their current actions will influence their future, focus on investment in their future, believe that they will have a future that matters, believe in planning for developing their future, and look far into the future for assessing the effects of their current actions. (Shi & Wang, 2011, p. 99)

Shi and Wang (2011) observed, “Both [the] Hofstede Model and [the] GLOBE Model are highly valuable research studies in international business and management” (p. 96). Given the prevalence of Hofstede’s et al. (2010) model in IT research, I elected to use it as the cultural framework for this research.

Hofstede et al. (2010) defined culture as “the collective programming of the mind that distinguished the members of one group or category of people from others” (Hofstede et al., 2010, p. 6). This programming of the mind (mental models) embodies learned patterns of thinking, feeling, and acting (Hofstede et al., 2010, p. 8). Johnson and Filippini (2010) commented, “… we can calculate cultural distance as a measure of the distance between average values on attitudes and practices for the individuals within a specific culture” (p. 24). For example, Table 1 below shows the Japanese and US index scores for Hofstede’s five dimensions of national culture and supports potential different orientation to work and work practices.

Table 1. National Culture – Hofstede's Index Scores for Japan and US

Hofstede Dimension	US Index Score	Japanese Index Score	Cultural Distance
1. Power Distance	40	54	14
2. Individualism	91	46	45
3. Masculinity	95	62	33
4. Uncertainty Avoidance	46	92	46
5. Long-Term Orientation	26	88	62

An analysis of the cultural distance column of Table 1 indicates the largest areas of cultural difference (i.e. learned patterns of thinking, feeling, and acting) for DMS Global will likely be long-term orientation, followed by uncertainty avoidance, and then individualism. Figure 2 is a graphic representation of the data in Table 1.

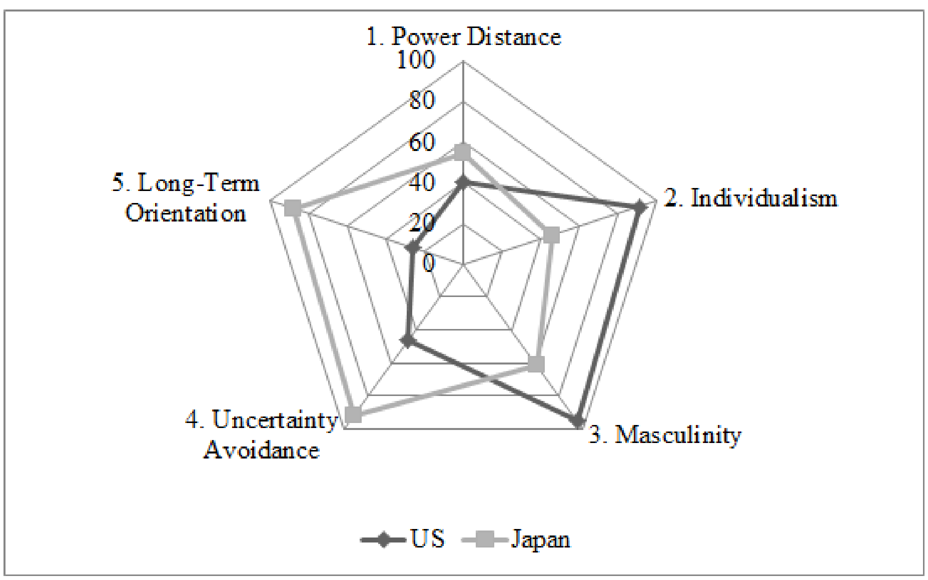

Figure 2. National Culture – Hofstede's Index Scores for Japan and US

Figure 2 highlights the significant cultural gaps (long-term orientation, uncertainty avoidance, and individualism) that DMS Global needed to overcome to realize a common enterprise-wide PLM IS used by US and Japanese associates.

Condon (1984) advised meaning often lies below the surface and offered the following two "rules" to US associates as an aid to understand their Japanese counterparts:

1. Rule One: if you notice a difference, realize that difference in itself may not be so important. It's what you don't notice that counts.
2. Rule Two: in almost everything in Japan there is some unseen or unstated meaning which is usually not pointed out but which everybody is supposed to know. So my advice is to look for the underlying meanings. (p. 6)

The cultural depth of meaning is further explored in the next section that considers culture and IS.

Culture and IS implementation.

For the DMS Global PLM IS to achieve its vision of success (common engineering systems, processes and procedures across geographies), and to improve integration and productivity, people across the DMS Global enterprise were required to think, feel, and act differently than they do with today's current systems, processes and procedures (Brynjolfsson & Hitt, 1998, p. 3). DMS would need to find a way to span, or narrow, their cultural gaps. To this end, Early (2006) recommended research move away from value surveys toward development of theories and frameworks that explain the action / interaction among culture, perceptions, organization, and structures (p. 928). The recommendation from Early (2006) stimulated the following research question:

RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs?

Such a framework would be helpful to DMS Global. What cultural frameworks exist to assist IS implementations?

Hofstede et al. (2010) claimed national culture was multi-layered and comprised of symbols, heroes, rituals, and values (see Figure 3 below) (p. 8). The first three layers, visible to the external observer, were collectively termed practices (Hofstede et al., 2010, p. 9). The inner core of values, typically learned by age ten, represented broad tendencies or feelings to prefer one state of affairs over another (Hofstede et al., 2010, p. 9). The cultural depth of change required to realize the DMS Global PLM IS was significant, diving below the level of practices down to the level of long-held core values.

Drawing on the multi-layered nature of culture, Karahanna, Evaristo, and Srite (2005), presented a hierarchical model, or framework, (from general to specific) of culture that includes the following five levels:

1. Supranational (regional, ethnic, religious, linguistic): Any cultural differences that cross national boundaries or can be seen to exist in more than one nation.
2. National: Collective properties that are ascribed to citizens of countries (Hofstede 1984).
3. Professional: Focus on the distinction between loyalty to the employing organization versus loyalty to the industry (Gouldner, 1957).
4. Organizational: The social and normative glue that holds organizations together (Siehl & Martin, 1990).

5. Group: Cultural differences that are contained within a single group, workgroup, or other collection of individuals at a level less than that of an organization. (p. 5)

Karahanna et al. (2005) observed an individual's behavior in the workplace represented a simultaneous blending of multiple layers of culture (p. 3). They claimed that the layer of culture which weighed most heavily on behavior was driven by the nature of the task:

> Various levels of culture interact to form an individual's culture and to shape behavior. It is our contention, however, that depending on the behavior, different level of culture will have a dominant influence on an individual's actions. Building on the fact that national and supranational levels of culture influence one's values, then it follows that behaviors that involve consideration of values as a major component of the decision as to whether to engage in a behavior will be influenced by national and supranational culture. On the other hand, behaviors that involve practices will more likely be influenced by professional and organizational cultures. (Karahanna et al., 2005, p. 7)

The following graphic (Figure 3), adapted from Karahanna et al. (2005), illustrates the change in relative importance between values and practices at various levels of culture and integrates Hofstede's (2010) conception of practices and values:

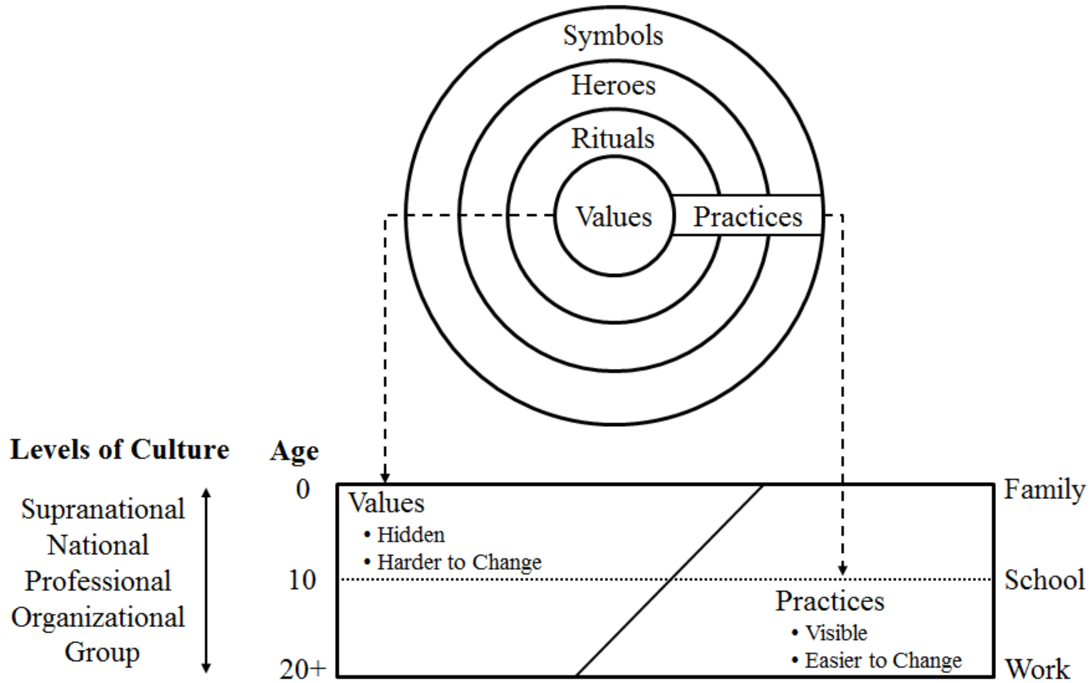

Figure 3. Relative Importance of Practices and Values by Cultural Level

The research by Karahanna et al. (2005) motivated the following research questions:

RQ1: How does vision of success for global PLM IS vary by culture?

RQ2: How do goals for global PLM IS vary by culture?

RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation?

RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs?

The primary levels of culture affecting the DMS Global PLM IS implementation were national (US and Japanese) and professional (engineering and IT). A secondary level of culture associated with the DMS Global PLM project was organizational (management and professional). Hofstede et al. (2010), however, cautioned that management culture should not be viewed in isolation from national societies (p. 25). An additional observation arising from

Figure 3 is that change related to long held values is more difficult and time consuming than change related to practices (Hofstede et al., 2010, p. 19).

When researching innovation, market orientation, and organizational learning, Hurley and Hult (1998) conceptualized organizational culture as an antecedent to innovativeness (p. 44). They defined innovativeness as, “the openness to new ideas as an aspect of a firm’s culture” (Hurley & Hult, 1998, p. 44). To assess innovativeness, Hurley and Hult (1998) surveyed a large research and development organization of the US federal government and asked respondents to rate the following five statements regarding innovativeness on a 1 (not descriptive) to 5 (descriptive) Likert scale:

1. Technical innovation, based on research results, is readily accepted.
2. Management actively seeks innovative ideas.
3. Innovation is readily accepted in program/project management.
4. People are penalized for new ideas that don’t work.
5. Innovation in XYZ is perceived as too risky and is resisted. (p. 49)

Openness to new ideas was required for the DMS Global PLM IS to meet its objectives. It was prudent, therefore, for this research incorporated Hurley and Hult’s (1998) five statements regarding innovativeness of the organizational culture as this, along with the foregoing review of culture and IS, may have bearing on the DMS Global PLM IS implementation.

Culture and PLM IS implementation.

Hu et al. (2006), when studying the challenges associated with PLM IS in trans-national environments noted, “In an era of intense global competition, firms realize that the effective use of global sourcing contributes significantly to the market performance” (para. 4) As customer demands increase and product life cycles decrease, the need to efficiently share product data between different units, companies, and countries grows (Hu et al., 2006, para. 6-7). Hu et al. (2006) found the following four dimensions of global product engineering:

1. Cultural differences
2. Standards and interoperability
3. Engineering tools
4. Intellectual property (para. 8)

When considering culture, Hu et al., (2006) comment, "Different societies and cultures had distinct ways of working and cultural norms that could lead to challenges when attempting cross-border collaborations" (para. 9). Their observations prompted the following research questions:

RQ1: How does vision of success for global PLM IS vary by culture?

RQ2: How do goals for global PLM IS vary by culture?

RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation?

Similarly, Penaranda, Mejia, Romero, and Molina (2010) provided a review of the challenges associated with PLM IS implementation from the academic literature (p. 854). The also conducted a case study of a small and medium sized integration engineering and construction enterprise in Mexico (Penaranda et al., 2010, p. 864). A key finding of their research was:

> *The cultural change*. It is very difficult to change the way that some people are used to work[ing]. The main barriers to success of PLM implementation may be: weak project management leadership, weak participation and commitment of team members

(particularly the core team) and a lack of integration with geographically distributed partners. (p. 873)

In response to these challenges, Penaranda et al, (2010) called for "a systematic, methodological and technically supported approach to develop and sustain a successful PLM implementation in an enterprise, which is aligned to achieve a complete enterprise integration" (p. 854). Their call for a framework to align the PLM IS implementation with strategic objective echoed the following research questions:

RQ1: How does vision of success for global PLM IS vary by culture?

RQ2: How do goals for global PLM IS vary by culture?

RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation?

RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs?

Cantamessa et al. (2012) also considered the impact of organizational culture on PLM IS implementation in an aerospace company (p. 199). They note that while the enterprise-wide implementation of a PLM IS is typically accomplished by a top-down executive mandate, there exists significant organizational conditions that, "affect the usability and impact of these technologies on their job and – ultimately – the degree with which they use them" (Cantamessa et al., 2012, p. 192). Their survey discovered the actual organizational impact of the PLM IS is moderated not only by the fit of the technology to users' tasks, but also by the degree to which management has designed and supported the technology (Cantamessa et al., 2012, p. 192). The cultural nature of their findings confirmed the following research questions:

RQ1: How does vision of success for global PLM IS vary by culture?

RQ2: How do goals for global PLM IS vary by culture?

RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation?

RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs?

Having considered the integration of culture and PLM IS implementation, the following section summarizes the culture section of the literature review.

Culture literature review summary.

The implementation of a PLM IS is a complex and challenging endeavor. When multiple cultures are involved, complexity and challenge grow. Faced with the daunting challenges of implementing a common enterprise-wide PLM IS, growing resistance to change aggravated in part by the existence of multiple cultures, and a paucity of literature from which to draw practical implementation advice, how could DMS Global best proceed? How could they address the problem posed by disparate legacy systems and realize the PLM project vision of common engineering systems, processes, and procedures that would allow DMS Global to share information, share resources, share load, and "chase the sun?" What could DMS Global do, when confronted with these broad and deep issues, to focus their limited resources on the aspects of the PLM project most likely to assure success? What were the CSFs for a global PLM IS implementation?

CSFs Literature Review

CSFs.

The review of the CSF domain was organized in three subsections which progress through the early history of CSFs. The first subsection explored the genesis of CSFs. The second subsection examined the first five years of CSF history. The third subsection provided a summary of the CSF before transitioning to the following section related to CSFs and IS.

CSFs: the genesis.

Daniel (1961) introduced the term “success factors” into the management literature in 1961. Rockart (1979) popularized a method to elicit “critical success factors” from chief executives in 1979. These two seminal articles form the foundation of CSFs.

Management information crisis: Daniel, 1961.

Daniel (1961) began his Harvard Business Review article titled “Management Information Crisis” with three vignettes of companies who were struggling to make management decisions because they lacked quality information. He observed, “In retrospect it is obvious that these three companies were plagued by a common problem: inadequate management information. The data were inadequate, not in the sense of there not being enough, but in terms of relevancy for setting objectives, for shaping alternative strategies, for making decisions, and for measuring results against planned goals” (Daniel, 1961, p. 111). This observation supported the following research questions:

RQ1: How does vision of success for global PLM IS vary by culture?

RQ2: How do goals for global PLM IS vary by culture?

Daniel was fearful that the response to the management information crisis would be a marked increase in the quantity and detail of information. He cautioned, “Excessive detail is the quicksand of intelligent planning” (Daniel, 1961, p. 119). Others shared Daniel’s concern. He noted, “In many organizations the initial reaction to the management information problem is first evidenced by a concern over ‘the flood of paper work.’ Eventually, the problem itself is recognized – i.e., the need to define concisely the information required for intelligent planning and control of a business" (Daniel, 1961, p. 119). To avoid an "information flood," Daniel (1961) advised, "… a company's information system must be discriminating and selective. It should focus on 'success factors.' In most industries there a usually three to six factors that determine success; these key jobs must be done exceedingly well for a company to be successful" (p. 116). Daniel's (1961) call for a limited number of success factors motivated the following research question:

RQ3: What are the CSFs for global PLM IS implementation?

Chief executives define their own data needs: Rockart, 1979.

Rockart (1979) credited Daniel as being the first to use the concept of "success factors" in the management literature (p. 85). Eighteen years after Daniels article, the problem of inadequate information remained. Rockart (1979) described the difficulty as, "Once one gets above the functional level, there is a wide variety of information that one might possibly need, and each functional specialty has an interest in 'feeding' particular data to a general manager…. a massive information flow occurs" (p. 81). There was a problem defining concisely exactly what information senior manager's required (Rockart, 1979, p. 82). In other words, general managers were drowning in data, but starved for information. Like Daniel (1961), Rockart (1979) advocated a limited number of critical success factors which aligned with the follow research question:

RQ3: What are the CSFs for global PLM IS implementation?

It is prudent at this point in the literature review to pause and provide operations definitions of data, information, and knowledge. Davenport (1979) defines data as "observations of states of the world" (p. 9). That is data, "… is a set of discrete, objective facts about events" (Davenport & Prusak, 2000, p. 2). In an organization setting, data may be described as inventory balances or transaction records (Davenport, 1997, p. 9) (Davenport & Prusak, 2000, p. 2). Skovira (2007) provides a genealogy of the term data and notes, "the word 'data' simply means the 'givens', literally 'those-things-having-been-given'" (p. 260). Debons (2008) describes data as "simple measurements around us" (p. 5).

Data is transformed into information by the addition of "relevance and purpose" (Davenport & Prusak, 2000, p. 4). Whereas data is static, Davenport and Prusak (2000) note the dynamic nature of information when they describe it as messages that move around organizations through "hard and soft networks" (p. 3). The informational messages are endowed with value through several important methods:

- Contextualized: we know for what purpose the data was gathered.
- Categorized: we know the units of analysis or key components of the data.
- Calculated: the data may have been analyzed mathematically or statistically.
- Corrected: error have been removed from the data.
- Condensed: the data may have been summarized in a more concise form. (Davenport & Prusak, 2000, p. 4)

Knowledge has more depth, breath, and richness than information (Davenport & Prusak, 2000, p. 5). Davenport (1979) observed:

> *Knowledge* is information with the most value and is consequently the hardest form to manage. It is valuable precisely because somebody has given the information context, meaning, a particular interpretation; somebody has reflected on knowledge, added their own wisdom to it, and considered its larger implications. (p. 9)

Knowledge requires people. People transform information into knowledge by:

- *Comparison*: how does information about this situation compare to other situations we have known?
- *Consequences*: what implications does the information have for decisions and actions?
- *Connections*: how does this bit of knowledge relate to others?
- *Conversations*: what do other people think about this information? (Davenport & Prusak, 2000, p. 6)

Skovira (2007) agreed and commented, "Knowledge is uniquely human because it is about the meanings of things for individuals even as the individual is part of situations within organizations or social groups" (p. 261). The social, or cultural, nature of knowledge was also captured in Davenport and Prusak's (2000) following definition of knowledge:

> Knowledge is a fluid mix of framed experiences, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the mind of the knowers. In organizations, it often becomes embedded not only in documents or repositories but also in organizational routines, processes, practices, and norms. (p. 5)

Nonaka and Konno (1998) identified two forms of knowledge: explicit knowledge and tacit knowledge (p. 42). Explicit knowledge is relatively easy to transmit between individuals and can be expressed in, "words and numbers and shared in the form of data, scientific formulae, specifications, manuals, and the like" (Nonaka & Konno, 1998, p. 42). Nonaka and Konno (1998) described tacit knowledge as follows:

> Tacit knowledge highly personal and hard to formalize, making it difficult to communicate or share with others. Subjective insights, intuitions, and hunches fall into

this category of knowledge. Tacit knowledge is deeply rooted in an individual's actions and experience as well as the ideals, values, or emotion's he or she embraces. (p. 42)

Davenport and Prusak (2000) presented data, information, and knowledge as a continuum where human involvement increases as we move from data to information to knowledge (p. 10). Of the three, knowledge is the most valuable and most complex. Knowledge has both an explicit and tacit dimension; both of which are influenced by cultural practices and values.

Leaving the definition of data, information, and knowledge, and returning to Rockart (1979), he provided an analysis of the then four current approaches to determining managerial information needs (i.e. by-product technique, null approach, key indicator system, and total study process), and then he proposed a new "superior methodology" to elicit CSFs from chief executives (pp. 82–85). He defined CSFs as, "the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organization. CSFs are the few key areas where 'things must go right;' for the business to flourish" (Rockart, 1979, p. 85). Rockart (1979) also offered a CSF method that involved two, and sometimes three, interviews with the chief executive to define: goals, CSFs supporting the goals, measure supporting the CSFs, and information supporting the measures (p. 85). Rockart's (1979) method reinforced the following research question:

RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs?

CSFs: the first five years.

In 1979, Rockart (1979) predicted broader applications of his CSF method when he noted, "The CSF concept itself is useful for more than information system design" (p. 88).

Similarly, Boynton and Zmud (1984) foresaw the value of CSFs for IS implementation projects. They commented:

> At an operational level, CSFs help ensure that critical organization information processing needs are explicitly addressed. The development of organizational CSFs and their use as a guideline for bounding and directing implementation efforts also provide a means to improve the overall integration of IS efforts (Boynton & Zmud, 1984, p. 19).

The vision of Boynton and Zmud (1984) paralleled the following research questions:

RQ3: What are the CSFs for global PLM IS implementation?

RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs?

Cooper (2009) studied the use of Rockart's (1979) CSF method in IS research (p. 9). Looking back on the then 30 year history of CSFs, Cooper (2009) observed:

> Since its initial inception, the CSF method has been adapted and extended to meet the needs of a wide range of research projects including: extensions to the domain and industries of applications; adaptations to the techniques used to elicit CSFs; and extensions to ways in which the results of CSF studies are presented" (p. 12).

This observation suggested the use of CSFs as a theoretical framework for PLM IS implementation and buoyed the following research questions:

RQ3: What are the CSFs for global PLM IS implementation?

RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation?

RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs?

Given the far-reaching impact of Rockart's (1979) CSF method, the following portions of the literature review offer a chronological history of its first five years. The five year mark provided a natural break point because after this point there was a three-year gap in the CSF literature. The motivation behind the detailed review of the early literature was to identify the key principles of the original method before considering how it has changed over time. The foundational principles of Rockart's (1979) original method proved to be instructive to this research.

The original CSF method: Rockart, 1979.

As noted above, the implementation of Rockart's (1979) CSF method involved two, and possibly three, interviews with the chief executive (p. 85). The objectives of the first interview were: to understand the executive's goals; to define the CSFs supporting the goals; to identify an initial set of measures for the CSFs; and to consider combining, restating, or eliminating CSFs (Rockart, 1979, p. 85). During the second interview, results of the first interview were reviewed; the CSFs were "sharpened up;" and measures and reports showing data/information were discussed in detail (Rockart, 1979, p. 85). The third, and final interview, was only required if the first two failed to obtain concurrence on the CSFs, measures-and-reporting sequence (Rockart, 1979, p. 85). I developed Figure 4 to graphically illustrate Rockart's CSF method.

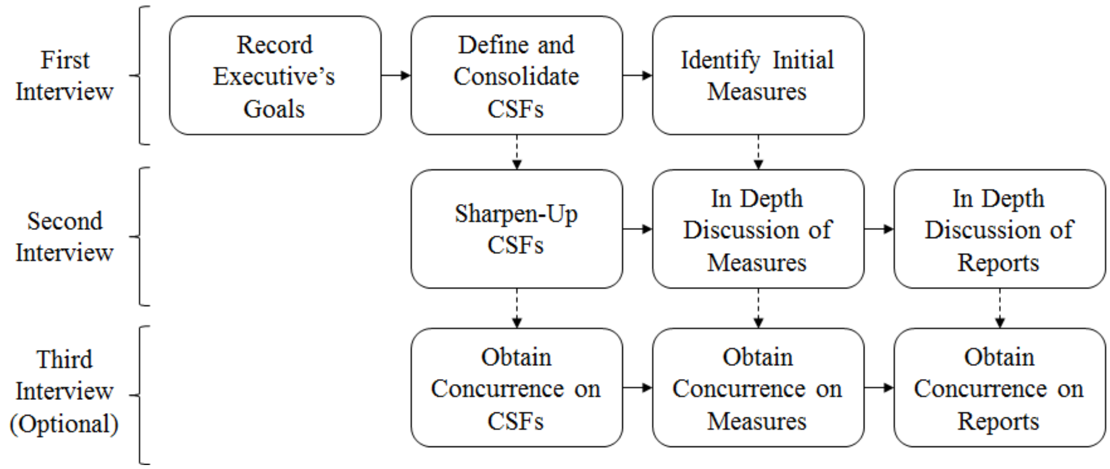

Figure 4. Rockart's Original CSF Method

While the focus of Rockart's (1979) article was on the chief executive, he did note that CSFs would be useful at each level of general management (p. 88). Rockart (1979) identified the following benefits likely to accrue by cascading CSFs through the layers of management:

- Helping the manager to determine factors on which to focus their attention.
- Forcing managers to develop good measures for CSFs.
- Clearing defining information needs and avoiding costly collection of more data than is required.
- Movement away from reporting data that is 'easy to collect' toward collection of data significant for the success of the particular management level.
- Acknowledging that some factors are temporal and, consequently, IS must change to meet business needs.
- The usefulness of CSFs extends beyond information system design to information system planning. Further, CSFs can be arranged hierarchically to aid management communication. (p. 88)

Rockart (1979) then demonstrated his CSF method and supported the benefits claimed above through the presentation of five cases (Microwave Associates, a major oil company, a store furnishings manufacturer, a government hospital, and a major electronics division) (pp. 88–92).

Early criticisms: Davis, 1979.

In response to Rockart's CSF method, Davis (1979) raised concerns that executives would not be able to provide CSFs that were, "complete, correct, and sufficient" (p. 57). Davis (1979) provided four underlying phenomena to support the concerns levied against Rockart's CSF method.

First, research had established that humans can hold seven ± two chunks of information in short term memory which Davis (1979) called the "human capacity for information processing" (p. 57). Accordingly, executives would naturally limit CSFs to seven to nine factors. But what if there were more than nine CSFs? Davis (1979) was fearful that the CSFs identified by executives would be only those that survive the human processing limitations (p. 57).

The second concern raised by Davis (1979) was a phenomenon called bounded rationality which claimed, "Humans have a limited capacity for rational thinking and therefore must construct simplified models of the real situation is order to deal with it" (p. 57). The risk was the simplified model would not correctly reflect the real situation (Davis, 1979, p. 57). Accordingly, CSFs obtained from a bounded model that did not reflect reality may, in turn, not reflect reality. Further, the model may be "restricted or bounded by experience, training, prejudice, custom, and attitude" (Davis, 1979, p. 57). In a word, the model may be restricted by culture. Davis' (1979) concerns regarding culture stimulated the following research questions:

RQ1: How does vision of success for global PLM IS vary by culture?

RQ2: How do goals for global PLM IS vary by culture?

RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation?

Third, Davis (1979) worried that humans may draw improper statistical conclusions based on small sample sizes or assert causality from joint concurrence of events due to "limits on humans as intuitive statisticians" (Davis, 1979, p. 57). In Davis' (1979) own words, "These limits on humans as intuitive statisticians may lead to incorrect conclusions by executives about the importance of causality of factors" (Davis, 1979, p. 57).

The fourth, and final, criticism of Davis (1979) was bias introduced by both the availability and correctness of data, or significant past events (Davis, 1979, p. 58). He was not only concerned that executives would omit CSFs for which data was difficult to gather, but also that the identification of CSFs would be unduly influenced by the recent past and/or significant past events which may, or may not, be recent (Davis, 1979, p. 58).

Davis (1979) concluded his article by calling for an analytical business model that could be used to elicit executive response and to justify CSFs for relevance, correctness, and completeness (p. 58).

A field study and a rebuttal: Munro & Wheeler, 1980.

In the year following Rockart's introduction of the CSF method and Davis' criticism of the same, Munro and Wheeler (1980) conducted a field study based on Rockart's original CSF method. The theoretical frame for the study was information requirements analysis (IRA) which begins with the premise, "a manager's information needs are best defined by exploring the manager's decision making responsibilities and cognitive style " (Munro & Wheeler, 1980, p. 28). Accordingly, for their field study, Munro and Wheeler focused on management control which they defined as, “the process of ensuring the resources are obtained and used effectively toward the attainment of corporate goals” (p. 28). The study was situated at a large natural resources company and included “senior middle level” managers who were tasked, at an earlier seminar, with (1) defining key business unit objectives in support of corporate strategy and (2) developing appropriate performance metrics for the business unit objectives (Munro & Wheeler, 1980, p. 29).

Munro & Wheeler (1980) interviewed an unspecified number of senior middle level executives. The interview duration was up to two and one half hours (Munro & Wheeler, 1980, p. 29). Their aim was to develop a general model which could be used by other managers faced with the challenge of defining the information needed to support management control (Munro & Wheeler, 1980, p. 28). Their desire to develop a model aligned with the following research question:

RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs?

The result of the field study was the following five step approach to determining the information requirements for management control:

1. Understand business unit objectives,
2. Identify Critical Success Factors,
3. Identify specific performance measure and standards,
4. Identify data required to measure performance, and
5. Identify decision and information required to implement the plan. (Munro & Wheeler, 1980, pp. 29–33)

The approached adopted by Munro and Wheeler (1980) is fundamentally the same as Rockart's (1979) CSF method. There were, however, minor variations in methods. Rockart (1979) focused on the chief executive and employed two, and sometimes three, interview (p. 85). Munro and Wheeler (1980) focused on senior middle level managers and conducted only one interview (p. 29).

In discussing their findings, Munro and Wheeler (1979) provided advantages and disadvantages of their CSF approach from both a managers and IS analyst's point of view. The primary advantages from the viewpoint of a manager were: the top-down alignment, or clear connection, between the manager's goals and the information needed for management control; information tailored to a manager's needs, and CSFs permitting rapid monitoring of performance; a more thorough understanding of the role a manager plays in obtaining corporate and business unit objectives gained from executing the CSF process; and adding some level of structure to "free-form," qualitative managerial jobs such as environmental affairs (Munro & Wheeler, 1980, pp. 33–35). The prime management disadvantage noted by Munro and Wheeler (1980) was the structure imposed by CSFs and performance measure may conflict with individuals with a highly entrepreneurial cognitive style and rely on their heuristic talents for success (p. 35).

From the IS analyst's perspective, the benefits of the CSF method included providing structure to the analyst's interviews, and a more manageable process as "[n]atural guidelines as to the relevance, accuracy, timeliness, and other information characteristics are inherent in the process by operating within the planning context" (Munro & Wheeler, 1980, pp. 35–36).

Munro & Wheeler (1980) also found three potential flaws with the CSF method from the analyst's perspective. First was the challenge of "soft" or qualitative measures. While surrogate measures offer some insight into qualitative date, they are not completely satisfactory (Munro & Wheeler, 1980, p. 36). Second, was the lack of a defined corporate strategy or business unit goals upon which to base the CSFs (Munro & Wheeler, 1980, p. 37). The third, and final, disadvantage was the dynamic nature of strategies, goals, and corresponding CSFs; as strategies and goals change to meet market needs, so too will CSFs (Munro & Wheeler, 1980, p. 37). Their focus on strategies, or vision of success, and goals reinforced the following research questions:

RQ1: How does vision of success for global PLM IS vary by culture?

RQ2: How do goals for global PLM IS vary by culture?

Munro and Wheeler (1980) also claimed developing CSFs within the planning context would allay the four concerns raised by Davis (1979). Davis' (1979) first concern was human processing limits may cause managers to restrict CSFs to nine or less causing them to overlook or fail to recall important factors (p. 57). Munro and Wheeler (1980) responded:

> This is a real possibility when the manager/analyst interviews are unstructured. However, using the approach in this article, the manager/analyst discussion is structured by the presence of goals and objectives identified earlier by the planning process. As a consequence, CSF's are generated in response to stimuli, i.e., goals and objectives as opposed to the analyst relying solely on the individual manager's limited information processing capabilities. (p. 36)

Davis' (1979) second, third, and fourth concerns were: bounded rationality, limitations as humans as intuitive statisticians, and the bias introduced due to data availability and or past significant events respectively (pp. 57–58). To overcome these concerns, Davis (1979) called for an analytical model that was relevant, complete, and correct (p. 58). Munro and Wheeler (1980) argued a relevant, complete, and correct analytical model is seldom available (1980, p. 36). They also suggested:

> Applying the CSF approach in a planning context may overcome the difficulties noted by Davis…. The key to this outcome is the explicit linkage between goals and objectives on the one hand, and critical success factors on the other. Since the margin for error on these dimensions is minimized by this linkage, an enhanced level of relevance, correctness, and completeness is inherent in the product. (Munro & Wheeler, 1980, p. 36)

Soliman et al. (2001), in their research study which employed CSFs and grounded theory methods towards the integration of ERP and CAD/CAM, provided additional perspective when they noted:

> In response to Davis's comments, Munro (1983) compared the results obtained from Rockart's CSF study (1982) and Martin's CSF study (1982a,b), Munro also examined both authors' articles in detail and compared the articles' citations and descriptions. As well as their interviews with senior IT/IS managers. He commented that the results from these two studies were interrelated and quite similar. He also concluded that the results from CSF methods are reasonable and that the CSF approach is a reliable technique, while acknowledging that the CSF approach could not be completely free from the bias of an interviewer's interests and perceptions, unless the interviews were skillful (Munro 1983). (as cited in Soliman et al., 2001, p. 614)

A primer: Bullen & Rockart, 1981.

In 1981 Bullen and Rockart authored a working paper titled "A Primer on Critical Success Factors" which allowed researchers to gain a deeper understanding of Rockart's original CSF method. Organized in four sections, the primer provided: an introduction; definitions and concepts; an interview procedure; and recommendations for the analysis of data (Bullen & Rockart, 1981, p. 2). A summary of each section follows.

The first section of the primer, the introduction, offered a basic overview of critical success factors, referred the interested reader to Rockart's (1979) original CSF article, and then provided an overview of the primer's contents.

The second section of the primer, definitions and concepts, was divided into two subsections. In the first subsection regarding definitions, Bullen and Rockart (1981) provided operational working definitions of the following management terms: strategy, objectives, goals, CSFs, measure, and problems (pp. 7–10). Their definitions were utilized in the following research questions:

RQ1: How does vision of success for global PLM IS vary by culture?

RQ2: How do goals for global PLM IS vary by culture?

RQ3: What are the CSFs for global PLM IS implementation?

In the second subsection pertaining to concepts, Bullen and Rockart (1981) expound upon not only the nature of CSFs but also the three major uses of CSFs (p. 11). Their discussion of the nature of CSFs covered five topics: the importance of CSF; different managers – different CSFs – different information; five prime sources of CSFs; a useful classification of CSFs; and the hierarchical nature of CSFs.

One item worthy of note was Bullen and Rockart's (1981) insistence on limiting the number of CSFs to the items on which the manager should focus their limited time and attention (p. 12). They commented:

> For this reason, the term 'critical success factors' is aptly chosen. They represent the few 'factors' which are 'critical' to the 'success' of the manger concerned. There are, in

> every mangers' life, an incredible number of things to which her attention can be diverted. The key to success for most managers is to focus their most limited resource (their time) on those things which really make the difference between success and failure. (Bullen & Rockart, 1981, p. 12)

Another significant concept expressed in this subsection was a CSF classification framework that integrated: the five prime sources of CSF; external versus internal CSFs; and monitoring versus building CSFs (Bullen & Rockart, 1981, p. 18). The framework was illustrated as a three-dimensional cube which allowed the analyst eliciting CSFs not only insight into the executives world view, but also multiple vantage points from which to stimulate CSF identification. They stated:

> Each CSF can be classified along three major dimensions. These are (1) internal versus external, (2) monitoring versus building, and (3) all of the five sources discussed just above. All three dimensions are ways of categorizing CSFs. The pattern of CSFs which emerge provides a good insight into a manager's world view. But the resulting pattern can also serve an interviewer as a source of questions. (Bullen & Rockart, 1981, pp. 16–17)

The allusion to a framework aligned with the following research question:

> RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs?

Continuing their subsection related to CSF concepts, Bullen and Rockart (1981) described the three uses of CSFs: to help an individual manager determine their information needs; to aid an organization in its general planning process; and to aid an organization in its IS planning process (p. 35). They observed an individual manager lives within the context of the larger corporation and that the corporate strategies, objectives, and goals drives the individual managers goals, CSFs, measures, reports, and data bases (Bullen & Rockart, 1981, pp. 35–38).

After individual manager CSFs are identified, they are consolidated and prioritized to determine the overall IS planning priorities (Bullen & Rockart, 1981, p. 39). CSFs that were common, or recurrent, across individual managers were candidates for consideration as corporate CSFs (Bullen & Rockart, 1981, p. 39).

Before concluding their review of the three uses of CSFs, Bullen and Rockart (1981) identified an area of significant value arising from the CSF interview process; insights into the manager's world view (p. 42). They noted:

> In addition to its yield for information systems planning, the CSF method provides an additional, perhaps equally important, benefit for the interviewer. This benefit is a relatively deep understanding of the way in which each senior manager interviewed views the world. In effect, the interviewed managers spend the interview time discussing their jobs as they see them, and the areas which they believe are most critical to them. Interviewers who have used the CSF process (in many cases the top person in information systems) have almost unanimously reported that this 'insight into top management and its view of the business' has been, by itself, of significant value to the I/S department. (pp. 42–43)

The theme of "world view" recurred as Bullen and Rockart (1981) moved to section three of the primer; interview procedure. It is here, however, I found yet another inkling of the intersection of CSFs and culture in the literature. The CSFs chosen by a manager reflect their view of the world. Similarly, the manager's world view affects their selection of CSFs. Accordingly, world view, or culture, is an antecedent of CSFs which suggested the following research questions:

RQ1: How does vision of success for global PLM IS vary by culture?

RQ2: How do goals for global PLM IS vary by culture?

RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation?

The third section of the primer, interview procedure, contained three subsections: objectives of the interview; pre-interview preparation; and interview procedure (Bullen & Rockart, 1981, p. 45). I incorporated many of their ideas in the in-depth interview protocol (Appendix E, Appendix I).

The fourth section of the primer, Bullen and Rockart (1981) offered several tips for analysis of data. The interviewer should categorize the CSFs within the three-dimensional cube to ensure no applicable major categories are omitted (Bullen & Rockart, 1981, pp. 56–57). Consider aggregating CSFs provided by the interviewee if the CSFs revolve around a common management concern (Bullen & Rockart, 1981, p. 57). Check to ensure the manager is not excluding CSFs for which data is difficult to gather (Bullen & Rockart, 1981, p. 57). Finally, Bullen and Rockart (1981) encouraged interviewers to "stretch" the manager's thinking regarding CSFs while avoiding "leading the witness" (Bullen & Rockart, 1981, p. 58). For example:

- Ask the manager to prioritize their CSFs. Bullen and Rockart (1981) note this is not a required step (pp. 58–59).
- Determine measure for each CSF as time permits. Measures can be added during the second, or third, CSF interview (Bullen & Rockart, 1981, pp. 59–60).

Taken together, these tips served to address the concerns of: human processing limits, bounded rationality, limitations as humans as intuitive statisticians, and the bias introduced due to data availability and or past significant events respectively raised by Davis (1979, pp. 57–58).

Diving deeper into the IS domain, the IS executive: Rockart, 1982.

Noticing the trends in IS toward managerial oriented IS executives, distributed data processing, and end user oriented systems, Rockart (1982) undertook an inductive case based study aimed at defining the changing role of the IS executive (p. 3,4). He employed his original CSF method to conduct four-hour interviews with the heads of IS of nine firms randomly selected from a list of 25 firms considered as "being outstanding by academic colleagues or by industry contacts" (Rockart, 1982, p. 4). Rockart's (1982) article titled, "The Changing Role of the Information System Executive: A Critical Success Factor Perspective," yielded the following three major findings:

1. The crucial success factors, as stated by each executive, differ from company to company, but they can be summarized as a set of four distinct critical success factors that we term and 'I/S executive CSF set.'
2. Each I/S executive has established a distinctive and broad set of managerial tools, techniques, and processes aimed at facilitating good performance in 'critical' areas.
3. Although individual executives differ in several ways, there are striking similarities in the managerial viewpoint of these nine executives. They exhibit many common managerial behaviors, as evidences in the interviews and as described by others. This 'profile' is worth considering as a role model for the I/S executive of the early 1980s. (pp. 4–5)

Drilling down to consider the CSFs in more detail, Rockart (1982) provided a table listing the CSFs resulting from each of the nine interviews (p. 6). Five executives listed five CSFs, two listed six CSFs, and one listed seven CSFs yielding a total of 50 CSFs. Noticing that many of the CSFs were similar across the nine IS executives, Rockart (1982) commented, “Abstracting from the CSF material generated in interviews at the nine companies, it appears that there are four CSFs for this type of I/S executive …. They are service, communication, I/S human resources, and repositioning the I/S function” (p. 8).

Following the aggregation of the 50 individual CSFs into four overall CSFs for IS executives, Rockart (1982) breaks down each one into a two-level hierarchy. For example, the first-level service CSF breaks down into two second-level CSFs of service level and perception of service (Rockart, 1982, p. 8). Similarly, the first-level communication CSF breaks down into three second-level CSFs of two-way communication, education of top management, and identification of user needs/priorities (Rockart, 1982, p. 8).

Next Rockart (1982) raised the question, “What is the cause of this variation in actual CSFs” (1982, p. 9)? He provided four answers. The first cause noted by Rockart (1982) were differences in the stage of development of the IS organization (p. 9). CSFs differ between mature and immature IS organization. The second cause was associated with the performance history of the IS organization (Rockart, 1982, p. 10). Rockart (1982) observed, “Companies in which service has been a problem often have service-oriented CSFs predominating …. Those in which I/S personnel have been a particular problem will tend to stress the human factor” (p. 10). The third is cause related to top management’s awareness of technology and the financial position of the firm (Rockart, 1982, p. 10). The fourth, and final cause, stemmed from world view as defined in the following quote:

The perspective or 'world view' that the I/S executive has on the field and on his role in the company …. Thus CSFs are obviously a reflection of an executive's perspective on his role. They will, and do, vary with the personality of the I/S director himself" (Rockart, 1982, p. 10).

Rockart (1982) continues the imagery of "reflection" when he stated, "Just as I/S CSFs reflect an executive's views of his role, so do they mirror the executives himself" (p. 12). CSFs not only echo the role (position, duties, or practices) of a CSF, but also provide a "window into the soul" of the executive himself (his core, his values). The mention of world view and reflecting a executives view of his role gave rise to the following research questions:

RQ1: How does vision of success for global PLM IS vary by culture?

RQ2: How do goals for global PLM IS vary by culture?

RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation?

RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs?

Venturing outside the IS domain, the board: Ferguson & Dickson, 1982.

Ferguson and Dickson (1982) were the first to apply CSFs outside the domain of IS (to the domain of the board of directors of a firm) and the first to employ a different CSF methodology (an a priori listing of CSFs). After crediting Daniel (1961) with the introduction of CSFs into the IS literature, they recommend utilizing CSFs as a tool to bridge the gap between the board of directors and the management of a corporation (Ferguson & Dickinson, 1982, p. 15, 16). They posed two questions:

1. How can the board serve the interest of the corporation without getting into matters that should be left in the hands of managers?
2. How can the board make a positive contribution to the corporation and not be merely the last bulwark against disasters? (Ferguson & Dickinson, 1982, p. 14)

Ferguson and Dickson (1982) defined CSFs as, “the factors inside or outside the company which must be identified and reckoned with because they support or threaten the achievement of company objectives, or even the existence of the company” (p. 15). Noting that the board has a “detached perspective,” Ferguson and Dickson (1982) claimed this vantage point afforded a unique opportunity to ask questions that led to the identification of CSFs (p. 15). Without asking questions, however, nor providing any evidence of a literature review or research study, Ferguson and Dickson (1982) recommend, a priori, four CSFs to the board of directors for the 1980s:

1. Coping with inflation,
2. Ensuring the adequacy of financial and managerial resources,
3. Finding and keeping a competitive position and
4. Strategic development. (p. 15)

They did note, however, there were likely other CSFs for each company (Ferguson & Dickinson, 1982, p. 16).

Ferguson and Dickson (1982) offered a four step procedure for CSFs to boards who were interested in becoming more active in the governance of the corporation (p. 18). As they chose to apply CSFs outside the domain of information, similarly, they chose to utilize a methodology different than Rockart’s (1979) original CSF method. Whereas Rockart (1979) relied on interviews to elicit CSF that align with executive goals, Ferguson and Dickson (1982) advised the board to independently (1) establish goals and objectives, (2) identify CSFs, (3) audit the company's vulnerability to the CSFs, and (4) recommend corporate development strategies to comply with CSFs (p. 18). Similar to Rockart's (1979) original CSF method, Ferguson and Dickson (1982) called for each CSF to have tests, or measures, to assess the company's performance against the CSF; and they provided several measures for each of the four CSFs in their article (1982, pp. 16–18).

Adapting the methodology, surveys replace interviews: Martin, 1982.

Martin (1982) also deviated from Rockart's (1979) original CSF domain and method. He noted that while Rockart's (1979) CSF method chose to focus on the chief executive, "it is equally applicable to any organization and to any managerial level within an organization in which multiple functions report to the manager" (Martin, 1982, p. 1). Martin (1982) chose to focus his study on identifying the CSFs for the MIS/DP (management information systems / data processing) organization by surveying 15 executives directly responsible for MIS/DP function (p. 2,4). Most of the executives were associated with an advisory council for the Indiana University School of Business graduate program where Martin (1982) served on the faculty (p. 2).

Acknowledging Davis' (1979) criticism that the interviewer may introduce bias, Martin (1982) chose to employ a two-phase survey methodology (p. 2). The first survey phase gathered (a) demographic data on the MIS/DP manager and his organization, (b) objectives of the MIS/DP manager to establish a context for CSFs, and (c) and offered space for CSFs for the MIS/DP manager to list up to eight CSFs (Martin, 1982, p. 2).

The demographic data included age, tenure with the organization, educational background, title of the MIS/DP manager, and title of the individual to whom the MIS/DP manager reported (Martin, 1982, p. 3). The second survey included a consolidated summary of the results of the first survey and gave the MIS/DP managers an opportunity to review the results and then submit a revised set of CSFs (Martin, 1982, p. 2).

The two surveys yielded the following consolidated list of seven general CSFs for MIS/DP organizations (Martin, 1982, p. 4):

1. System development
2. Data processing operations
3. Human resources development
4. Management control of the MIS/DP organization
5. Relationships with the management of the parent organization
6. Support of the objectives and priorities of the parent organization
7. Management of change

Martin (1982) noted the consolidation list of general CSFs, "were developed by a subjective trial and error process" (p. 4).

The consolidated CSFs were presented in a table where the rows were the 15 MIS/DP managers and the columns were the seven CSF (Martin, 1982, p. 5). An "X" at the intersection of a manager and CSF indicated the manager had included the CSF in his surveys. The order of the columns proceeded from the CSFs included by the most managers (14 of 15 or 93.33%) to the CSFs included by the least managers (6 of 15 or 40.00%); with four CSFs tied at 11 of 15 managers (73.33%).

Martin (1982) devoted several paragraphs to the description of each CSF (pp. 4–7). He observed the higher level CSF could be broken down hierarchically into a lower level CSFs. For example, "system development" breaks down into "project selection, effective project management, ability to respond effectively to the user needs within a reasonable time frame, and the development of reliable, timely, and cost effective application systems" (Martin, 1982, p. 4). Whereas Rockart (1979) moved from CSFs, to measures, to information needs, Martin (1982) moved from higher level CSFs, to lower level CSFs, to measures, to information needs (p. 8). Higher level CSFs such as "system development" are difficult to quantify and measure. Lower level CSFs, such as on-time project delivery, which support higher level CSFs such as system development, are easier to quantify and measure.

In discussing the findings, Martin (1982) commented, "It should be noted that an area could be quite crucial to MIS/DP success, but a manager probably would not mention it among personal CSF's if it were under such complete control that it never was a problem" (p. 4). In other words, a CSF may be omitted if performance against the CSF were satisfactory. Martin (1982) positioned CSFs as a framework that provided value to both top management and MIS/DP managers (p. 8). For top management, the CSF framework offered areas on which to focus attention and evaluate performance (Martin, 1982, p. 8). Similarly, for MIS/DP managers, the CSF framework allowed a manager to: compare his CSFs with Martin's (1982) list of seven CSFs for MIS/DP functions (p. 8). Martin's (1982) conclusions regarding general managers, MIS/DP managers, and frameworks align with the following research questions:

RQ3: What are the CSFs for global PLM IS implementation?

RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation?

RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs?

Strengths and weaknesses, two cases studies: Boynton & Zmud, 1984.

Observing the broad applicability of CSFs, Boynton and Zmud (1984) conducted two case studies (i.e. a financial services firm and a state university) aimed at understanding the strengths and weaknesses of the CSF method (p. 17). Their chosen domains were MIS planning and requirements analysis (Boynton & Zmud, 1984, p. 19). Following the advice of Bullen and Rockart's (1981) primer, Boynton & Zmud (1984) interviewed multiple layers of management representing a cross section of the organization's functional areas (Boynton & Zmud, 1984, p. 17).

Boynton and Zmud (1984) identified four strengths of the CSF method (pp. 24–25). First, CSFs provided effective support to the MIS planning process. Second, CSFs offered insights into IS services that could impact the organization's competitive position in the marketplace. Third, senior leaders identified with and strongly supported the CSF concept. Fourth, and finally, CSFs promoted a structured analysis of the top level conceptual model of the key facets of an organization to be managed.

Conversely, Boynton and Zmud (1983) identified three weaknesses of the CSF method (pp. 24–25). First, managers farther removed from senior positions experienced difficulty identifying meaningful organizational CSFs. Second, managers not involved in strategic or tactical planning struggled with the conceptual nature of CSFs. Third, and finally, some managers had difficulty transitioning from CSFs to the information needed to monitor, or support, the CSF.

Following the analysis of CSF strengths and weaknesses, Boynton and Zmud (1984) commented:

> CSFs are flexible and do not require a rigorous format in their use of interpretation. This offers an advantage as CSFs can be tailored to different applications, as is seen in the

growing number of uses proposed for CSFs in MIS and other organizational domains. (p. 25)

Next they suggested six guidelines regarding when, where, and how to use CSFs:

1. CSFs are an excellent tool for information resource planning.
2. When attempting to translate CSFs into specific information needs for a manager, the use of prototyping is recommended as a means of product development.
3. The individual managing the CSF effort should have a thorough understanding of the organization or should, at least, be literate in the organization's principle area of business.
4. Because it is desirable to access managers throughout the organization in some CSF projects, it is useful to identify and cultivate a senior-level manager to champion the project.
5. Do not make an overt attempt to identify CSFs with information technologies when conducting interviews.
6. Planning efforts can be enhanced by conducting CSF interviews on multiple levels. (pp. 25–26)

Their comments regarding the application of CSFs to other domains align with the following research question:

RQ3: What are the CSFs for global PLM IS implementation?

In conclusion, Boynton and Zmud (1984) claimed, "most, if not all, of the criticisms identified by Davis can be overcome if an analyst aggregates CSFs obtained from interviews conducted across a diagonal slice of an organization" (p. 26). Given most organizations are arranged hierarchically by function (Magal & Word, 2011, p. 2), a diagonal slice of an organization, which included multiple management layers and functional disciplines, would yield a mix of management levels and functional disciplines.

Adding decision scenarios and prototypes: Rockart & Crescenzi, 1984.

While engaged as consultants at Southwestern Ohio Steel (SOS), Rockart and Crescenzi (1984) extended the CSF method by adding decision scenario and prototypes to the methodology (pp. 3–4). The SOS case proceeded in three phases. The first phase linked management needs of the business with IS and utilized CSFs (Rockart & Crescenzi, 1984, p. 5). The second phase identified IS priorities and gained management confidence through decision scenarios (Rockart & Crescenzi, 1984, p. 5). The third phase provided a proof of concept via prototyping (Rockart & Crescenzi, 1984, p. 5).

Phase one began with an introduction workshop that provided an overview of the three-phase method to five key managers and focused on defining the mission and objectives of the business (Rockart & Crescenzi, 1984, p. 7). Next, the project team conducted individual CSF interviews with the 15 key managers (Rockart & Crescenzi, 1984, p. 7). The phase concluded with a workshop that consolidated 40 CSFs gained from the individual interviews into four (Rockart & Crescenzi, 1984, p. 8). Rockart and Crescenzi (1984) note, "This is the most significant and difficult step in the first phase, for different individual perspectives, managerial loyalties, and desires emerge" (p. 8). When reflecting on the value of the focusing workshop, they observed:

> In the course of the focusing workshop, what had previously been implicit was made explicit – sometimes with surprising, and insightful results. In Jacque Huber's [vice president of sales] words: 'We all knew what was critical for our company, but the discussion – sharing and agreeing – was really important. What came out of it was a

> minor revelation. Seeing it on the blackboard in black and white is much more significant than carrying around a set of ideas which are merely intuitively felt.' (Rockart & Crescenzi, 1984, p. 8)

The CSF technique not only linked business needs to CSFs, but also made tacit, or silent, knowledge explicit.

Phase two began with a workshop aimed at defining a set of measures to be used to evaluate the CSFs from phase one (Rockart & Crescenzi, 1984, p. 9). The project team found three distinct IS that would support the majority of the management information needs (Rockart & Crescenzi, 1984, p. 9). The transition from business objectives and CSFs to IS, however, was not a straightforward, simple process for the SOS managers. To gain confidence that the three IS would meet management needs, the project team employed a new technique termed, "decision scenarios" (Rockart & Crescenzi, 1984, p. 9) Decision scenarios were defined as:

> Recurring decisions along with the questions managers asked of themselves and others in order to make decisions. From these 'decision situations,' a set of 'decision scenarios' was developed. Each decision scenario was concerned with a particular managerial event and the questions which might have been instrumental in formulation of a decision. All relevant questions, both those which could be answered by computer-based data and those which could note, were included in the scenario. (Rockart & Crescenzi, 1984, p. 9)

In reflecting on the findings of their use of decision scenarios, Rockart and Crescenzi (1984) observed:

> By working through a series of scenarios, the managers were able to gain a much greater familiarity with and insight into the workings of the proposed systems. They were able to see what questions would be answered by the new systems, what questions would not be

answered, and how the data would be presented through 'paper models' of proposed screen formats. (p. 11)

Decision scenarios and paper models led naturally to the third phase.

Phase three began with a focus on developing prototypes (Rockart & Crescenzi, 1984, p. 11). Prototypes were realized in one of three forms. First were "information databases;" defined as "a collection of data made accessible to users" which allowed users not only to gain insight into the data they really need but also to develop an understanding of the method of access required to utilize the data (Rockart & Crescenzi, 1984, p. 11). Second were "pilot systems" which offered full functionality on a subset of a process or business area (Rockart & Crescenzi, 1984, p. 11). Third were "classical prototypes" which offered an incomplete set of system functionality (Rockart & Crescenzi, 1984, p. 11). After multiple rounds of rapid prototype development, trail use, and redesign, the three IS matured and were used by managers and operational personnel at all levels (Rockart & Crescenzi, 1984, p. 13).

Rockart and Crescenzi (1984) claimed the three phase approach of CSFs, decision scenarios, and prototyping, on one level delivered substantial business benefits, and on another, more significant level, strongly affected the management team in a positive manner (p. 14). They noted the following four areas in which managerial attitude were positively affected:

1. A sharper focus in the minds of all top managers on the few important things to which they must direct their attention.
2. An increased understanding of the interdependencies of the various parts of the business and the ability, through the computers system, to take advantage of this knowledge.

3. The transfer of a sizable segment of this knowledge from the retiring chairman to the younger management team which was made possible through the multiple workshops in which various aspects of the business, particularly the most critical ones, were discussed.

4. The direct terminal-based access that management now has to data on various aspects of the status of the company. (Rockart & Crescenzi, 1984, p. 14)

Rockart and Crescenzi (1984) concluded by stating their belief that the CSF method will work well in other companies provided the management team is ready to engage and competitive pressures are driving a need to rethink IS priorities (p. 15).

Operational definitions and integrated action: Dickinson et al., 1984.

Observing that the CSF method was achieving recognition in diverse fields, Dickinson, Ferguson, and Sircar (1984) undertook to define and analyze CSFs in a comprehensive manner (p. 23). They defined CSFs as:

> Events, circumstances, conditions, or activities that require special attention because of their significance to the corporation. They can be internal or external and can influence the success of the corporation either positively or negatively. Their essential character is the need for a special awareness or early warning system to avoid unpleasant surprises or missed opportunities. (Dickinson et al., 1984, p. 24)

Implied in this definition was the idea that CSFs need to be made operational to be of use (Dickinson et al., 1984, p. 25). Each CSF would require a set of parameters to be measured and monitored to support management review and decision making (Dickinson et al., 1984, p. 25). Tracking measures for CSFs often required new, or modified, IS; hence CSF offered a natural starting point for IS planning and design (Dickinson et al., 1984, pp. 24–25).

Dickinson et al. (1984) recommended a cascading, or water falling, of CSFs from corporate plans, down to business unit plans, down to IS plans (1984, pp. 26–27). At each level of planning, CSFs should be identified that convert general objectives into concrete decisions and actions (Dickinson et al., 1984, p. 26-27). Using IS as an example, Dickinson et al. (1984) commented:

> Incorporating CSFs into the planning process will force an interaction between users and top management on the one hand and Information Management on the other, to yield an information system action plan which will be consistent with corporate and business unit goals, and will therefore be more meaningful. (p. 27)

Dickinson et al. (1984) observed an added benefit that often resultsed from integrated hierarchical planning; specifically the identification of comprehensive, integrated, cross-functional, IS that support the needs of multiple user groups and management levels (pp. 26–27). In summarizing the advantages of the CSF, Dickinson, et al. (1984) noted the following three:

1. It provides a method for making corporate goals and objectives operational.
2. The CSF approach is comprehensive. It is a systematic method for identifying all actions which ought to be undertaken, including contingency planning.
3. The approach is flexible. (p. 26)

CSFs summary.

In 1979, Rockart (1979) predicted broader applications of his CSF method when he noted, “The CSF concept itself is useful for more than information system design” (p. 88). His predictions were accurate. The following section reviews the use of CSFs for IS implementation.

CSFs and IS implementation.

CSFs have been used in a wide variety of IS implementation work. For example, CSFs were identified for CRM by Rahimi and Berman (2009) as well as Croteau and Li (2003). Similarly, Siemieuniuch and Sinclare (2004) found 14 factors that help ensure that an organization is ready for a Knowledge Lifecycle Management (pp. 87–14). Likewise, Tan et al. (2009) document six CSFs necessary for the implementation of the Information Technology Infrastructure Library (ITIL). Olszak and Ziemba (2012) employed CSFs in their research regarding the implementation of business intelligence IS for small and medium sized enterprises (p. 132). The vast majority of the CSF IS related research, however, has focused on ERP. The following subsections review selected articles related to CSF and ERP implementation which I found beneficial to this research.

Somers and Nelson, 2001.

Somers and Nelson (2001) recognized a growing demand for Enterprise Resource Planning (ERP) systems and focused their research on defining CSFs for the implementation of ERP systems (p. 1). While several researchers had identified "success factors" for ERP implementations, there was a lack of broad-based empirical research on ERP CSFs (Somers & Nelson, 2001, p. 1). In response, Somers and Nelson (2001) undertook an empirical study to determine not only which CSFs are most critical in the ERP implementation process, but also to which of the six stages/phases (i.e. initiation, adoption, adaptation, acceptance, routinization, and infusion) of the implementation project the CSFs applied (p. 2).

Through an extensive review of the literature, Somers and Nelson (2001) developed a list of 22 CSFs associated with project/system implementations (p. 2). Next they established a random sample of 700 companies drawn from Fortune 500 firms and the Directory of Top

Computer Executives (Somers & Nelson, 2001, pp. 5-6). A survey instrument was developed that included clear, short descriptions of the six stages/phases of implementation and a list of the 22 CSFs (Somers & Nelson, 2001, p. 6). Following pilot testing of a questionnaire, the survey and a cover letter stating the purpose of the survey and ensuring confidentiality, were mailed to the senior IS executive in the sample (Somers & Nelson, 2001, p. 6). Survey respondents were asked to, "(1) identify the degree of importance of each CSF in their ERP implementation overall, using a 5-point scale, ranging from low to critical (including NR = not applicable) and, (2) indicate in which stage of the implementation (i.e., initiation, adoption, adaption, acceptance, routinization, infusion) the particular CSF was important" (Somers & Nelson, 2001, p. 6).

From the 700 surveys mailed, Somers and Nelson (2001) received 86 responses (Somers & Nelson, 2001, p. 6). They calculated the mean and standard deviation for the 22 CSFs, then used the mean to sort the 22 CSFs in descending rank-order of overall importance to the implementation to ERP systems (Somers & Nelson, 2001, pp. 6–7). Somers and Nelson (2001) also analyzed the survey data regarding which stages/phases a CSF applied. For each stage/phase, they listed the five CSFs that were most frequently identified as being important for the stage/phase (Somers & Nelson, 2001, p. 7). The results clearly show the relative importance of CSFs change through the project lifecycle. Further, several CSFs were important in more than one project stage/phase. For example, the CSF of top management support was identified as important in five of six phases. This makes sense as top management support had the highest mean importance score making it the most critical CSF overall. Surprising, the CSF of project management was the fifth most critical CSF, but project management was not identified as important in any of the six project stages/phases. In concluding, Somers and Nelson (2001) note:

> ERP implementations represent high risk projects that need to be managed properly. Organizations must learn how to identify the critical issues that affect the implementation process and know when in the process to address them effectively to ensure that the promised benefits can be realized and potential failures can be avoided. (p. 8)

Plant and Willcocks, 2007.

Plant and Willcocks (2007) leveraged the CSFs of Somers and Nelson and conducted two longitudinal case studies that considered 22 CSFs for international ERP system implementation success (2007, p. 10). Their research yielded the following three primary findings:

1. Like the study of Somers and Nelson (2001), the importance of CSFs changed through the project lifecycle (Plant & Willcocks, 2007, p. 63).
2. The CSFs for domestic only versus an international project were different (Plant & Willcocks, 2007, pp. 63–64).
3. The utilization of bilingual international vendors was a CSF in global ERP implementations (Plant & Willcocks, 2007, p. 66).

Their finding of differences in CSFs between domestic and international project supported the following research questions:

RQ1: How does vision of success for global PLM IS vary by culture?

RQ2: How do goals for global PLM IS vary by culture?

RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation?

Françoise, Bourgault, and Pellerin, 2009.

Continuing in an international vein, Françoise, Bourgault, and Pellerin (2009) identified concrete practical actions management could take to realize CSFs for ERP implementations.

Their research included a literature review that identified 13 CSFs, followed by a Delphi survey with a panel of ERP experts (Françoise et al., 2009, pp. 374, 378). One of their 13 CSFs was organizational culture and change management (Françoise et al., 2009, p. 374). When discussing the impact of culture on successful ERP IS implementation they commented:

> The implementation of good change management practices is absolutely crucial, since an ERP necessarily leads to changes in how things are done and therefore to reluctance on the part of end-users. This aspect of the management of ERP implementation is one of the most difficult ones for managers to deal with and few authors indicate what steps should be taken. Every company has a culture, which may or may not be strong and enduring, and which may be reflected in either openness to change or the opposite. (Françoise et al., 2009, p. 374)

The challenges associated with organizational culture and change management encouraged the following research questions:

RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation?

RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs?

Lin and Rohm, 2009.

Lin and Rohm (2009), in their research concerning the implementation of ERP in China, sought to understand the relative difference in importance of CSFs between managers and end-users (p. 528). Their research found, "significant differences do exist in the perception of managers and end-users. It further shows that both managers and end-users of Chinese companies rate all seven factors lower than do their US counterparts" (F. Lin & Rohm, 2009, p. 540). The results of Lin and Rohm (2009) suggested the following research questions:

RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation?

Frimpon 2011.

Frimpon (2011), during his research on the implementation of ERP in a University in Ghana, West Africa, identified 28 CSFs from the literature (p. 233). Frimpon (2011) analyzed the interrelationships between the 28 CSFs and aggregated the 28 CSFs into the following five key roles:

1. Top Management
2. Technical Management
3. Process Management
4. Change Management
5. Project management (240–241).

A role was defined as, "a group of CSFs identified and put together for the purpose of achieving a sub-objective of the main objective" (Frimpon, 2011, p. 233).

The primary motivation for consolidating CSFs was to reduce complexity. Frimpon (2011) notes:

> An analytical restructuring that clearly shows the interplay and relationships of the CSFs and the possible elimination of unnecessary interactions can result in a reduction of complexity. With 28 independent CSFs, the number of pairwise comparisons is 387. Restructure the 28 CSFs into five roles yields 79 pairwise comparisons (69 pairwise comparisons of the CSFs within the roles and 10 pairwise comparisons between the

roles); a reduction of 299 pairwise comparisons. Reducing the complexity will result in better management of the CSFs and a reduction in failure rates. (p. 223)

When providing recommended actions for the change management role, Frimpon (2011) advocated, "Preach strongly against cultural practices such as a lack of adherence to time, schedules, 'lateness to meetings', 'use of cell phones during meetings', and other non-value adding behaviors that can militate against implementation success" (p. 235). This mention of cultural practices supported the following research questions:

RQ1: How does vision of success for global PLM IS vary by culture?

RQ2: How do goals for global PLM IS vary by culture?

RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation?

CSFs and IS implementation summary.

While a relatively large body of knowledge exists regarding CSFs and ERP IS implementations, Cantamessa et al. (2012) claimed this literature may not be directly applicable to PLM IS implementation, because of the following two fundamental differences between ERP and PLM:

1. PLM technologies are less prescriptive over the ways in which tasks must be accomplished. Their use at the individual level is thus partially voluntary, as use of some features provided by the system are not compulsory for accomplishing some tasks in engineering and design jobs.
2. PLM is not intended to support routine and short-lived transaction-oriented processes. With respect to most other business processes, NPD [New Product Development] is inherently less predictable, of significantly longer duration, and more knowledge-

> intensive (often depending on tacit knowledge), and it involves very large teams that must cooperate across both the company and its supply chain. (p. 192)

Perhaps Rockart's CSF method would overcome these two differences.

CSFs and PLM IS implementation.

Soliman et al. (2001), focused on the integration of CAD/CAM, a technological component supporting PLM and ERP. They recommended using CSFs to not only focus limited management attention, but also to help assure project success (Soliman et al., 2001, p. 615). They noted, "there appears to be some confidence and support for obtaining CSF for integration of CAD/CAM systems with ERP systems" (Soliman et al., 2001, p. 615). Using grounded theory investigation and a panel of experts, Soliman et al., (2001) developed the following eight CSF for the integration of CAD/CAM and ERP systems (pp. 617–618):

1. CAD/CAM user's appreciation of integration;
2. Communication between design office and other users;
3. Design office services and support functions;
4. Management commitment and support;
5. Organizational effectiveness;
6. Training of CAD/CAM staff on ERP system;
7. Security of CAD/CAM interface; and
8. User friendliness of ERP systems.

Beyond the study by Soliman et al., (2001), I found no other academic literature related to CSFs for PLM IS implementation. This is not surprising given Schuh et al. (2008) claimed, "there is a research and literature gap regarding PLM information system implementation issues" (p. 210).

Chapter 2 Literature Review Summary

The three objectives of the literature review were: to raise my level of theoretical sensitivity; to identify knowledge gaps in the form of research questions; and to identify methods to guide this research.

The literature asserted that significant changes in enterprise-wide engineering processes, roles, and responsibilities would be required for DMS Global to realize its PLM IS vision of success (Brynjolfsson and Hitt, 1998, p. 3). The complexity and challenged of the changes required of DMS Global were compounded by the existence of multiple cultures. Unfortunately, the academic literature was largely silent and offered little guidance (Schuh et al. 2008, p. 210). CSFs, however, had been used successfully in support of ERP IS implementations (Somers and Nelson, 2001, p. 1). Further, CSFs were recommended by Soliman et al. (2001) during their grounded theory research on CAD/CAM and ERP integration as a means to focus limited management attention and to help assure success (p. 615). Accordingly, the literature review proved valuable as it raised my theoretical sensitivity regarding global PLM IS implementations.

As the literature review progressed through the domains of PLM IS implementation, culture, and CSFs in a broad-to-narrow fashion, the following five research questions emerged:

RQ1: How does vision of success for global PLM IS vary by culture?

RQ2: How do goals for global PLM IS vary by culture?

RQ3: What are the CSFs for global PLM IS implementation?

RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation?

RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs?

Rockart's (1979) CSF method involved in-depth interviews (p. 85). Somers and Nelson (2001) employed a quantitative survey to identify the relative importance of CSFs during the phases of ERP IS implementations (p. 6). Cooper (2009) utilized focus groups to verify the results of her CSF data collection and analysis (p. 20). Accordingly, I leveraged and combined Rockart's (1979) CSF method and Strauss and Corbin's (1998) grounded theory methods as the theoretical framework underpinning for my three-stage mixed methods case study.

Chapter 3 Methodology

Introduction

DMS Global, a multinational designer, manufacturer, and servicer of engineer-to-order heavy industrial equipment had disparate engineering IS and processes that created a barrier to enterprise growth. In response, the firm launched a project in 2010 to implement a common enterprise-wide PLM IS. The cross-functional cross-cultural project team established the following broad and compelling vision of success, and then added depth to the vision by documenting 13 discrete goals to be realized:

> The Engineering Team's vision of success includes common engineering systems, processes and procedures. DMS will have the ability to share information, share resources, share load and the ability to "*Chase The Sun*". (DMS Global, 2010, p. 1)

As the magnitude of change required to achieve the vision permeated the project team, progress slowed and realization of the PLM vision was threatened.

Problem Statement

In and of itself, the implementation of a PLM IS was a complex and challenging technological and social endeavor. For DMS Global the complexity and challenge of global PLM IS implementations was further compounded by the presence of multiple cultures. Unfortunately, the academic literature was largely silent and offered little empirical or theoretical help. Simply put, there was no theoretical framework to guide global PLM IS implementations.

Purpose of the Study

The purpose of this research was twofold. The primary purpose was to explore the challenges associated with global PLM IS implementations through the holistic analysis of the single instrumental DMS Global case (Creswell, 2007, p. 74, 75). The secondary aim was to develop a preliminary theoretical framework that modeled the process of implementing a global PLM IS in an engineer-to-order multi-cultural environment similar to DMS Global.

Research Questions

The lack of a theoretical framework integrating global PLM IS implementations, culture, and CSFs led to the formation of the following research questions:

RQ1: How does vision of success for global PLM IS vary by culture?

RQ2: How do goals for global PLM IS vary by culture?

RQ3: What are the CSFs for global PLM IS implementation?

RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation?

RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs?

Ethics

To ensure an ethical study I obtained approval from the Robert Morris University IRB (Appendix A) before commencing data collection. Similarly, I received approval from the DMS Global Chief Operating Officer (Appendix B) to conduct the study. Further, I secured informed consent from in-depth interview participants (Appendix C) and avoided deception by communicating the purpose of the study (Appendix D). The informed consent secured during in-depth interviews also covered the focus groups.

Privacy and anonymity of the participants was protected by assigning them a randomly generated unique identification number. The firm's privacy was secured by using the alias "DMS Global." Throughout the study, I took care not to disturb the worksite and to avoid stereotyping across cultures. Finally, ahead of the field work, I considered reciprocity and decided not to offer any financial incentives.

Bracketing Bias

I was employed by DMS Global from January 2011 through June 2012. During this time period I was the Manager of IT Systems Analysis Services and a member of the PLM project team working under the direction of the US engineering project lead. Prior to joining DMS Global, I had 25.5 years of industry experience holding positions in both information technology (IT) and operations. In an IT capacity, I served as a software engineer; systems analyst; project manager; manager of programming, quality assurance, and architecture; director of IT governance and program management; and director of business service demand management. In an operational capacity, my areas of employment included production supervision, master scheduling, materials management, and industrial engineering. Both IT and operations experiences included international project work.

My background uniquely positioned me to study this phenomenon. As Creswell (2007) noted, "The result of this data collection and analysis is a theory, a substantive-level theory, written by a researcher close to a specific problem or population of people" (p. 67). Strauss and Corbin (1990) were also supportive of a researcher exploring a problem space in which they had professional and personal knowledge. This intimate knowledge gives a researcher theoretical sensitivity; "… the attribute of having insight, the ability to give meaning to data, the capacity to understand, and capability to separate the pertinent from that which isn't" (Strauss & Corbin, 1990, p. 42). For example, a researcher with field experience has a foundational knowledge of how things work and can more quickly understand actions and interactions in the research problem space (Strauss & Corbin, 1990, p. 42).

The proximity to the problem and population, however, raised the possibility of researcher bias. To the best of my ability, I set aside my experience and took a fresh perspective to the study. Strauss and Corbin (1990) offered three suggestions to avoid bias:

1. Periodically step back and ask: What is going on here? Does what I think I see fit the reality of the data?
2. Maintain an attitude of skepticism. All theoretical explanations, categories, hypotheses, and questions about the data, whether they come directly or indirectly from the making of comparisons, the literature, or from experience, should be regarded as provisional. They always need to be checked out, played against the actual data, and never accepted as fact.
3. Follow the research procedures. The data collection and analytic procedures are designed to give rigor to a study. At the same time they help you break through biases, and lead you to examine at least some of your assumptions that might otherwise affect an unrealistic reading of the data. (pp. 44–46)

In the results chapter, I used reflexivity to disclose my stance regarding the phenomenon and the data. Further, I utilized peer review and member checking to ensure a valid and reliable account.

Research Design

The primary purpose of this research was to explore the challenges associated with global PLM IS implementations. Accordingly, I approached this research as an instrumental case study. An instrumental case is one which, "… focuses on an issue or concern and then selects one bounded case to illustrate the issue" (Creswell, 2007, p. 74). The enterprise-wide implementation of the Windchill PLM IS at DMS Global provided a good case to study.

The secondary aim of the research was to develop a preliminary theoretical framework that modeled the process of implementing a global PLM IS. To meet this aim, I employed methods from grounded theory that sought to, "… systematically develop a theory that explains a process, action, or interaction on a topic …" (Creswell, 2007, p. 64). Soliman (2001) et al. also used grounded theory methods in their study of CSFs for the integration of CAD/CAM and ERP. Strauss and Corbin (1990) described grounded theory as one "… that is inductively derived from the study of the phenomenon it represents" (p. 23). Creswell (2007) describes the data collection and analysis in grounded theory as, "… a 'zigzag' process: out to the field to gather information, into the office to analyze the data, back to the field to gather more information, into the office, and so forth" (p. 64).

Considering the primary and secondary goals of the study, the research design chosen was case study with mixed methods. Mixed methods is a term applied when research strategies are employed that are not typically described as being part of a given approach to inquiry (*Handbook of mixed methods in social & behavioral research*, 2003, p. 192).The *Handbook of Mixed Methods in Social & Behavioral Research* (2003) provides the following representative examples:

> For instance, in quantitative inquiry, it may be the incorporation of an observational component (a non-numerical fieldwork component) or supplementary open-ended question at the end of a Likert scale; in qualitative inquiry (e.g., in grounded theory), it may involve the incorporation of strategies from ethnography to add a cultural dimension or the addition of quantitative measures. (p. 192)

Strauss and Corbin (1998), when discussing the interplay between qualitative and quantitative methods noted, "The qualitative should direct the quantitative and the quantitative feedback into the qualitative in a circular, but at the same time evolving, process with each method contributing to the theory in ways that only each can" (p. 34).

This case study research employed mixed methods and progressed through three-stages of data collection and analysis as indicated by Figure 5.

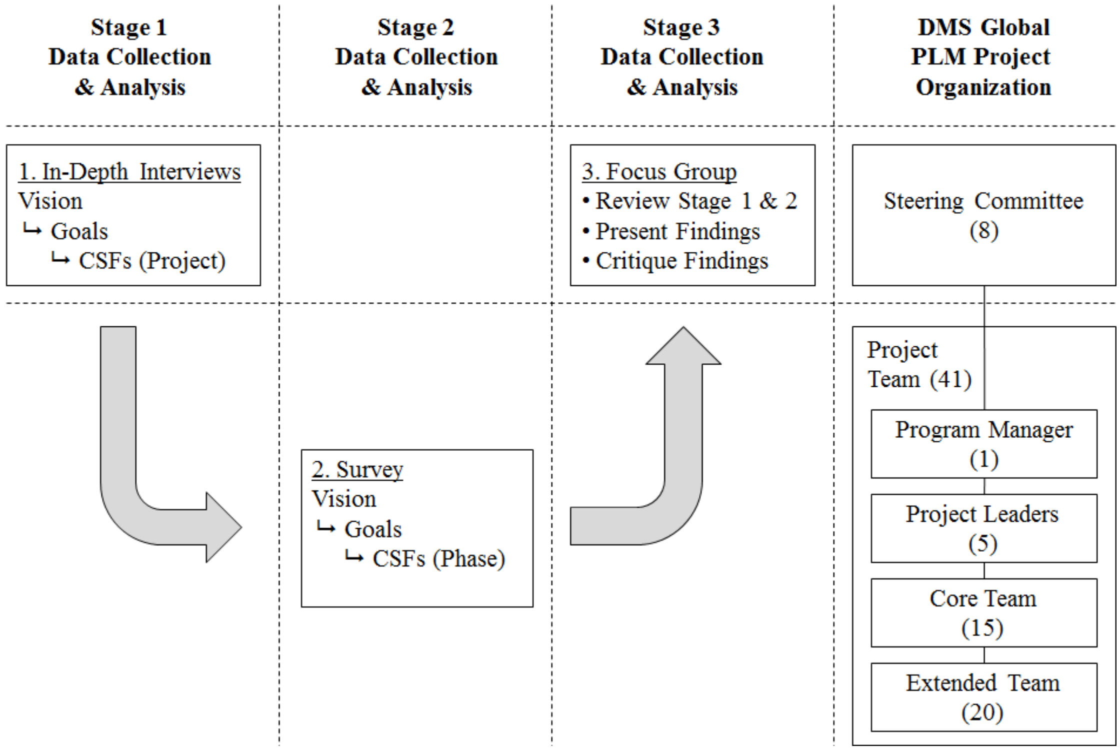

Figure 5. Research Design – Case Study with Mixed Methods

The participant population (the right-hand column of Figure 5) was the DMS Global PLM project steering committee (eight members) and project team (41 members). The participants were purposefully chosen because they had experienced the phenomenon (Creswell, 2007, p. 54, 126) and represented a diagonal slice, or cross section of management levels and business functions, of the organization (Boynton & Zmud, 1984, p. 26). Both the steering committee and project team included Japanese and US associates (national culture), along with engineering and IT associates (professional culture). All participation was voluntary.

The following three paragraphs provide a brief, high-level, overview of the three-stages of data collection and analysis. Conversely, the following three sections (i.e. Stage One: In-Depth Interview Data Collection and Analysis; Stage Two: Survey Data Collection and Analysis; Stage Three: Focus Group Data Collection and Analysis) provide the details of the methods employed during the three-stages of data collection and analysis.

The first stage of data collection and analysis was in-depth interviews with the eight members of the DMS Global PLM project steering committee. Appendix E contains the in-depth interview protocol. Appendix I is a matrix that traces from the in-depth interview questions to the research questions and from the in-depth interview questions to the supporting literature. Data from the in-depth interviews was analyzed to produce a consolidated list of CSFs that were used as input to the second stage of data collection and analysis.

The second stage of data collection and analysis was a survey of the 41 members of DMS Global PLM the project team. Appendix F provides the survey protocol. Appendix J is a matrix that traces from the survey questions to the research questions and from the survey questions to the supporting literature. Before proceeding to the third stage of data collection and analysis, a quantitative analysis was performed on the stage two survey data. The quantitative analysis identified CSF mean importance rating for the five project phases, and identified CSFs with statistically significant differences in mean importance rating for national (Japanese and US) and professional culture (engineering and IT) for the five project phases.

The third stage of data collection and analysis was two identical focus groups. All eight members of the DMS Global PLM steering committee were invited to both focus groups and advised they could attend either one of the two focus groups that best suited their schedule. This approach was chosen to minimize social pressure to participate since it will be less obvious if a steering committee member did not attend either focus group meeting. Appendix G provides the focus group protocol. Appendix K provides a matrix that traces from the focus group question/activity to the research questions and from the focus group question/activity to the supporting literature.

Stage One: In-Depth Interview Data Collection and Analysis

Participants.

The in-depth interview participants were the eight members of the DMS Global PLM project steering committee. The participants were purposefully chosen because they had experienced the phenomenon (Creswell, 2007, p. 54, 126). The population included representation from all four business units of DMS Global. The national culture mix was 63.5% US and 37.5% Japanese. The professional (functional job) culture mix was 62.5% engineering, 12.5% general management, and 25% IT. All members of the steering committee were male.

Building rapport with the DMS global PLM project steering committee was not difficult as I had worked with these individuals for more than a year and a half on the PLM project before leaving DMS Global to pursue other career opportunities. Access, however, presented some challenges as I did not have access to the DMS Global online scheduling systems (i.e. Lotus Notes). Accordingly, in May 2013, I recruited two DMS Global facilitators; one bilingual (English and Japanese) for the Japanese associates, and one English speaking facilitator for the US associates. Both facilitators were members of the PLM project team. As part of the on boarding process for the DMS global facilitators, I conducted a WebEx meeting with them on

May 20, 2013. During this meeting, we reviewed the three stage data collection and analysis plan and I answered questions they had regarding the research.

Protocol.

The in-depth interview protocol was created to gather data necessary to answer the research questions and employed practices used by other researchers found during the literature review. Appendix E contains the in-depth interview protocol. Appendix I is a matrix that traces from the in-depth interview questions to the research questions and from the in-depth interview questions to the supporting literature.

The objectives of the in-depth interviews were to collect demographic data; to identify the PLM project vision of success; to document PLM system goals that break down the vision of success into specific targets to be attained; and to elicit CSFs that support the vision and goals. The interview protocol consisted of the following eight sections:

1. Description of the purpose of the research.
2. Review of Informed consent which confirmed the participant's willingness to participate in the study.
3. Collection of demographic data regarding the participant.
4. Discussion of "vision of success," and gathering the participant's understanding of the PLM project vision of success.
5. Discussion of the term "goals" and gathering of the participant understands of the PLM project goals.
6. Discussion of "critical success factors" and gathering of the participant's understanding of the PLM project critical success factors.

7. Open forum where the participant was encouraged to provide additional information they felt would be helpful to this research.
8. Concluding remarks which thanked the participant for their time and input, and described the next steps in the research.

While most CSF methods identify measures, or metrics, that support CSFs (Rockart, 1979; Munro and Wheeler, 1980; Bullen and Rockart, 1981; Ferguson and Dickson, 1982; Martin, 1982; Rockart and Crescenzi, 1984; Dickinson et al., 1984) the abundance of literature that documented measures was sufficient and this research effort moved past confirmed research findings. Further, asking DMS Global participants to invest time identifying measures appeared redundant; bordering on nuisance research.

The completed draft in-depth interview protocol was emailed to both DMS Global facilitators, as agreed during the May 20, 2013 WebEx meeting, for verification. The DMS global facilitators reviewed the protocol to ensure it made sense to them, and estimated the amount of time they thought would be required to complete the interview. Both facilitators confirmed the interview protocol was intelligible and estimated one hour for the interview. Further, they had no recommended changes to the protocol.

Data collection.

DMS Global facilitators scheduled individual meetings with the steering committee member via DMS Global's electronic calendaring system. Following the advice of Bullen and Rockart (1981, pp. 45–60), the meeting invitation included the objectives of the interview, definition of terms, and a copy of the informed consent form (Appendix C). The eight in-depth interviews occurred between June 12, 2013 and July 7, 2013. Interviews were planned for one and one half hours with a minimum of one half hour of slack time between interview sessions. I personally executed all the in-depth interviews.

Interviews with DMS Global associates located in the US were conducted in person in a conference room in the DMS Global western Pennsylvania facility. Interviews with DMS Global associates located in Japan were conducted using DMS Global's LifeSize video conferencing system. The LifeSize video conference system consisted of audio and two 70 inch wall-mounted video screen. One screen displayed a live video of the participant. The second screen displayed the survey protocol. Asynchronous interpretation services were utilized for the interviews with the Japanese associates. Specifically, I would speak in English, the interpreter would translate to Japanese, the DMS Global associate would respond in Japanese, and the interpreter would translate to English. Interviews were recorded (with permission of the participant) and later transcribed verbatim. I also scribed and maintained notes during the in-depth interviews.

I made eight soft copies of the in-depth interview protocol where each filename included the unique identification number of the participant in a revision number. An associate transcribed the recording of the in-depth interviews verbatim into the soft copies of the protocol. Each response to open ended in-depth interview questions was time stamped. Words spoken by me (beyond reading of the in-depth interview protocol) were included within square brackets. Two verifications were performed on the transcriptions. First, I listened to the recorded in-depth interview while reading the transcription and made corrections. Second, each updated transcript was sent to the participant with a request to review the transcript and advise of errors. Two of the eight participants responded to my request for member checking. The first had only spelling corrections. The second had no corrections.

Data analysis.

The data analysis technique used during this phase of the research was open coding from Strauss and Corbin's (1998) work on grounded theory. Methods from grounded theory were chosen because they allow the analyst to: step back from the data and critically analyze situations; recognize their tendency toward bias; think abstractly; be flexible and open to criticism; be sensitive to the words and actions of the participants; and be absorbed in the process (Strauss & Corbin, 1998, p. 7). These characteristics were required to avoid bias that may occur due to my former employment at DMS Global.

Strauss and Corbin (1998) defined open coding as the process in which:

> … data are broken down into discrete parts, closely examined, and compared for similarities and differences. Events, happenings, objects, and actions/interactions that are found to be conceptually similar in nature or related in meaning are grouped under more abstract concept termed 'categories.'" (Strauss & Corbin, 1998, p. 102)

Concepts are the names, or labels, that stand for discrete incidents, ideas, events, and actions (Strauss & Corbin, 1998, p. 105). The names may come from respondents themselves (referred to as "in vivo" codes) or from the analyst based on his experience and/or the context given by the transcript (Strauss & Corbin, 1998, p. 105). Categories are the names, or labels, resulting from the grouping of concepts into more abstract higher order concepts; they are derived from the data and stand for phenomena (Strauss & Corbin, 1998, p. 113-114). The data analysis proceeded with three major steps: open coding of the in-depth interview transcripts; development of CSFs; and an examination of the similarities and differences in the codes based on national culture.

The first major step of the data analysis was open coding of the in-depth interview transcripts. There were four major elements of the in-depth interviews to be coded: vision of success; goals; CSFs; and the open forum. Microanalysis was used during coding. Strauss and Corbin (1998) defined microanalysis as, "The detailed line-by-line analysis necessary at the beginning of the study to generate initial categories …" (p. 57). They observed:

> To discover anything new in data and to gain greater understanding, we must do more of the detail and discriminate type of analysis that we call 'microanalysis.' This form of analysis uses the procedures of comparative analysis, the asking of questions, and making use of analytical tools to break the data apart and dig beneath the surface. (Strauss & Corbin, 1998, p. 109)

The same four step procedure, pictured in Figure 6 and outlined below, was used for open coding of all four elements of the in-depth interview transcripts.

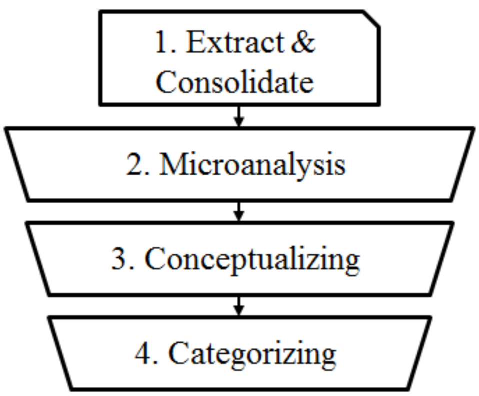

Figure 6. In-depth Interview – Open Coding Procedure Steps 1 to 4

1. Data Extraction and Consolidation
    a. To facilitate open coding, responses were copied from the Microsoft (MS) Word in-depth interview transcripts and consolidated into a MS Excel workbook. Each of the four elements of the in-depth interview to be coded (i.e. vision of success, goals, CSFs, open forum) were copied into a separate

worksheet. The data was copied to the worksheets in ascending unique identification number of the respondent. Each row in the worksheet contained a reference pointing to the unique identification number of the respondent. Before any data analysis or manipulation was performed, the rows were given a sequence number to ensure the original order of the data was preserved.

b. To verify no errors were made during the data extraction from the eight individual MS Word interview transcript documents and consolidation into the one MS Excel workbook, hard copies of the interview transcript documents and the consolidated workbook were printed and visually compared.

2. Microanalysis

a. I read the transcript and identified a single word, or phrase, of significance based on the context or my professional experience. Strauss and Corbin (1998) note, "Experience and knowledge are what sensitizes the researcher to significant problems and issues in the data and allows him or her to see alternative explanations…" (p. 59).

b. I created a list of synonyms for the word, or phrase (Strauss & Corbin, 1998, p. 92). The motivation was to examine the specifics of the data from different perspectives and to move me beyond my normal mode of thinking (Strauss & Corbin, 1990, p. 65). It is worth noting, "It is not the data that are being forced. The data are not being forced; they are being allowed to speak" (Strauss & Corbin, 1998, p. 65).

c. Based on the single word, or phrase, and the list of synonyms, I asked questions.

i. Some were sensitizing questions to tune me into what the data might be indicating (Strauss & Corbin, 1998, p. 77). For example: what's going on; who is involved; and what does this mean to them (Strauss & Corbin, 1998, p. 77)?

ii. Others were theoretical questions aimed at helping me see the process, variation, and connections (Strauss & Corbin, 1998, p. 77). For example: how would things be different if…; what changes over time; are there larger, or deeper, structural issues involved (Strauss & Corbin, 1998, p. 77)?

3. Conceptualizing

a. Having completed the microanalysis, I applied a name or label to serve as an abstract representation of the word, or phrase (Strauss & Corbin, 1998, p. 105). Where possible I used "in vivo codes" which is a name taken from the words of the respondent themselves (Strauss & Corbin, 1998, p. 105). When this was not possible, I used the name, or label, from the literature review or my professional experience.

b. Two types of memos were employed during this phase of the analysis. Strauss and Corbin (1998) defined memos as, "The researcher's record of analysis, thoughts, interpretations, questions, and directions for further data collection" (Strauss & Corbin, 1998, p. 217).

i. The first type was coding notes which captured my thoughts regarding the assignment of names, or labels, the concepts (Strauss & Corbin, 1998, p. 217).

ii. The second type was operational notes which contained procedural directions or reminders for me (Strauss & Corbin, 1998, p. 217).

4. Categorizing

   a. The list of concepts were grouped, or categorized, under broader, more complex, and more abstract category labels which served as headings for classes of objects that shared similar characteristics (Strauss & Corbin, 1998, pp. 114–115). The primary analytical tool used to group concepts into categories was comparison; "… The comparing incident to incident or object to object, looking for similarities and differences among their properties to classify them" (Strauss & Corbin, 1998, p. 95). As with categories, the names, or labels, for the categories were derived from: in vivo codes, the literature review, or my professional experience.

   b. Properties and dimensions were added to the categories to give them depth or thickness (Strauss & Corbin, 1998, p. 117). Properties are the characteristics or attributes that give it meaning (Strauss & Corbin, 1998, p. 101,117). Dimensions are the range, or set of values, that may be assigned to a property (Strauss & Corbin, 1998, p. 101,117). For example, several in-depth interviews had training and education as a CSF. Further, the in-depth interviewees used the following terms to describe the characteristics of training and education: appropriate; good manuals; initial and ongoing; good training; not generic but user specific; sufficient; etc. From these terms, I was able to develop the following properties of training with their dimensions in parentheses: quality (low – high); delivery (poor – excellent; untimely –

timely); content (inadequate – adequate; generic – job specific); documentation (week – robust; disorganized – integrated); etc.

The second major step of the data analysis was the development of the CSFs. The CSF procedure leveraged the outcome of the first four steps of the open coding procedure, and then added six additional steps (i.e. steps 5 - 10) as pictured in Figure 7 below.

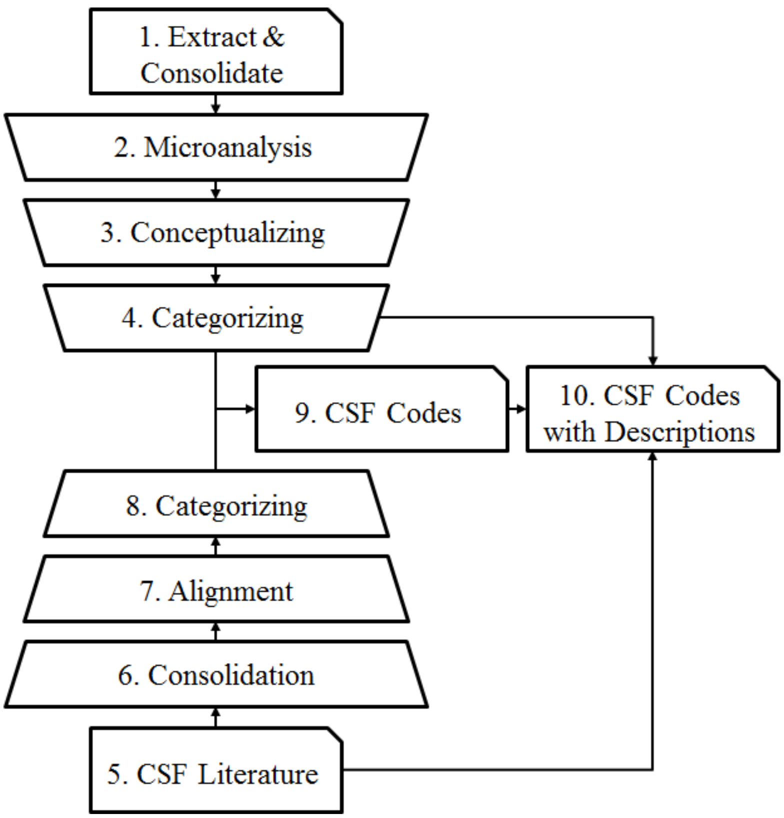

Figure 7. In-depth Interview – Open Coding Procedure Steps 1 to 10

The details of the steps five through ten follow:

5. CSF Literature

a. A review of the academic literature was conducted to find articles that provided consolidated lists of CSFs. This review produced the following seven sources, listed in ascending publication date order:

i. Somers & Nelson, 2001

ii. Soliman et al., 2001

iii. Plant & Willcocks, 2007

iv. Finney & Corbett, 2007

v. García-Sánchez & Pérez-Bernal, 2007

vi. Olszak & Ziemba, 2012

vii. Frimpon, 2011

6. Consolidation

a. The CSFs from the literature review were entered into a new worksheet titled "CSFs from lit" in the MS Excel workbook that contained the open coding of the in-depth interview transcripts. The worksheet had seven columns, one for each of the seven literature sources. The rows contained the CSFs from the literature.

7. Alignment

a. The individual CSFs in the rows of a MS Excel worksheet were then moved up, or down, so that each row contained similar CSFs.

8. Categorizing

a. For each row of similar CSFs, a broader, more complex, and more abstract category label was assigned (Strauss & Corbin, 1998, pp. 114–115). In some instances, the CSF category name was an amalgamation of the ideas resulting from the individual CSFs in the worksheet columns. For example, the category label of "consultant selection and relationship" came from the following five individual CSFs in the worksheet columns: use of consultants; use of consultants; consultant selection and relationship; having external consultants; and good performance by suppliers/contractors/consultants.

9. CSF Codes

   a. The next step of the procedure involved comparing the CSFs developed from the open coding of the in-depth interview transcript (i.e. procedural step 4 of Figure 7) with the CSFs developed from the literature review (i.e. procedural step 8 of Figure 7). This was an iterative, multistage, process as outlined below.

      i. First, I added a column titled "CSFs From Literature" to the MS Excel worksheet (titled "CSFs from DIs") which contained the CSFs derived from the open coding of the in-depth interview transcripts (i.e. procedural step 4 of Figure 7). MS Excel drop-down data validation was added to this column which referenced the list of CSFs that I developed from the review of the literature (i.e. procedural step 8 of Figure 7).

      ii. Second, using the MS Excel drop-down data validation, I assigned a CSF from the literature to each of the 200 rows in the worksheet of CSFs developed from the open coding of the in-depth interviews transcripts. If there was no CSF from the literature that corresponded to a CSF from the in-depth interviews, then I selected "N/A."

iii. Third, I sorted the MS Excel worksheet which contained the CSFs from the in-depth interview transcripts by the newly populated "CSFs From Literature" column. This sorting placed the rows of the MS Excel workbook for similar CSFs in close proximity to one another.

iv. Fourth, I added a column to the MS Excel worksheet which contained the CSFs from the in-depth interview transcripts titled "Final Category (Final CSF Code)."

v. Fifth, and finally, I created a final category (final CSF code), by reviewing the data in the multiple rows to which I have assigned the same "CSFs from Literature" value. In some instances, the final CSF code had the same label, or name, as the CSFs from the literature column. In other instances, however, the final CSF code was different from the CSFs from the literature column. This change, or deviation, was necessary when the CSFs from the literature did not fully capture the ideas and concepts raised during the in-depth interview, or when I wanted to include an in vivo code from the in-depth interview in the final CSF code. For example, the CSF from the literature was titled "Consultant Selection and Relationship" and I chose the label of "Consultant (System Integrator)" as the final CSF code because the term "System Integrator" occurred during two in-depth interviews with Japanese steering committee associates.

10. CSFs with Descriptions

   a. The final step of this procedure was to add a longer description to the final CSF code. Two sources of data were utilized to develop final CSF descriptions as indicated in Figure 7.

      i. The first source of data for final CSF descriptions came from the properties and dimensions developed during the open coding of the in-depth interviews (i.e. procedural step 4 of Figure 7). Specifically, I reviewed the properties and dimensions associated with the CSFs and developed a consolidated description. For example, properties and dimensions associated with the Consultant (System Integrator) CSF were: communication, engagement, expertise, high quality, partnership, reliability, and trustworthiness. The CSF description I developed from these properties and dimensions was " Consultant (System Integrator): Identify, evaluate, and select a PLM consulting firm that is not only technically competent, but also understands the DMS Global business and is willing to work collaboratively."

      ii. The second source of data for final CSF descriptions was the academic literature. Most articles contained both brief (i.e. five words of less) and long (i.e. a sentence to a paragraph) descriptions of CSFs.

   b. In many cases, a final description of the CSF was the result of blending CSF descriptions from the literature with dimensions of properties identified during the open coding of the in-depth interviews.

The third major step of the data analysis was an examination of the similarities and differences in the codes based on national culture. To accomplish this task, an MS Excel worksheet with nine columns was created. The first column contained the codes resulting from the microanalysis. Columns two through nine contained the respective unique identification numbers of the eight DMS Global PLM steering committee members who participated in the in-depth interviews along with their national culture (Japanese or US). For each row in the matrix, a "1" was placed under the interview participant column if the participant identified the code during their interview. MS Excel Pivot Tables were then generated to analyze similarities and differences by national culture.

Security, validity, and reliability.

Care was taken to ensure the security, and privacy of all data collected. Hard copy data was stored in a locked file. Security of electronic data included storing this data in encrypted password protected files using the TrueCryp software (http://www.truecrypt.org/). Backup copies of the encrypted electronic data were stored in a separate physical location from the original data.

As noted in the data collection section above, two verifications were performed on the in-depth interview transcriptions. First, I listened to the recorded in-depth interview while reading the transcription and made corrections. Second, each updated transcript was sent to the participant with a request to review the transcript and advise of errors. Two of the eight participants responded to my request for member checking. The first had only spelling corrections. The second had no corrections.

Reliability was assured through inter-coder verification. Two in-depth interview transcripts, one from a Japanese associate and a second from a US associate, were chosen at random (via random number generation in MS Excel). The responses to the following three in-depth interview questions were extracted from the transcripts and consolidated into a MS Word document:

1. Will you please tell me, in whatever order they come to mind, those things that you see as critical success factors for the DMS Global PLM project?
2. Let me ask the same questions concerning critical success factors in another way. In what one, two, or three areas would failure to perform well hurt the PLM project? In short, where would you most hate to see something go wrong in the PLM project?
3. Thank you; do you have any additional thoughts regarding PLM project critical success factors?

This MS Word document and the microanalysis procedure (Figure 7) described in the data analysis section above were sent to a peer who was also using Rockart's (1979) CSF method for his research. The peer was requested to use the microanalysis procedure to identify CSFs from the transcripts.

The peer identified 26 CSF codes from the transcripts. I identified 28 CSF codes from the same transcripts. I created an MS Word document that consolidated and aligned the peer's CSFs with my CSFs. I then shared this document with my peer and requested confirmation of the alignment. Following the peer's confirmation of alignment, we agreed on 26 of 28 CSFs yielding 92.85% inter-coder reliability. There were 14 duplicates among 28 CSF codes I found, yielding a net of 14 unique CSF codes.

Stage one: in-depth interview data collection and analysis summary.

Stage one data collection and analysis involved one and one half hour in-depth interviews with the eight member DMS Global PLM project steering committee. I personally conducted all interviews between June 12, 2013 and July 7, 2013 using the in-depth interview protocol documented in Appendix E. Interviews were recorded, transcribed verbatim, and then verified by member checking. Microanalysis was the primary method of data analysis (Strauss & Corbin, 1998, p. 57). Inter-coder verification yielded a 92.85% reliability rating. A key outcome of stage one data collection and analysis was the identification of 20 CSFs for the implementation of a Global PLM IS. These CSFs were incorporated into the stage two data collection and analysis; a quantitative survey of the DMS Global PLM project team.

Stage Two: Survey Data Collection and Analysis

Participants.

The survey participants were the 41 members of the DMS Global PLM project team. The participants were purposefully chosen because they had experienced the phenomenon (Creswell, 2007, p. 54, 126). The population included representation from all four business units of DMS Global and third party consultants engaged on the project. The national culture mix was 63% US, 24% Japan, 7% India, 3% Egypt, and 3% Lebanon. The professional (functional job) culture mix was 59% engineering and 41% IT. The gender mix was 90% male and 10% female.

Building rapport with the DMS Global project team was not required because the survey was web-based and did not involve personal interaction with the participants. I utilized the two DMS Global Facilitators to gain access. Specifically, the two facilitators sent an email on August 12, 2013 announcing the survey to the participants. The Japanese facilitator sent the announcement email to the Japanese participants. The US facilitator sent the announcement email to the non-Japanese participants. The DMS Global facilitators copied me on the announcement emails.

Protocol.

The survey protocol was created to gather data necessary to answer the research questions and employed practices used by other researchers found during the literature review. The protocol also incorporated the 20 PLM CSFs identified during the stage one in-depth interview data collection and analyses. Appendix F contains the in-depth interview protocol. Appendix J is a matrix that traces from the in-depth interview questions to the research questions and from the in-depth interview questions to the supporting literature.

The survey contained seven sections: introduction; demographic data; PLM project vision of success; PLM project goals; critical success factor importance by project phase, DMS Global openness to new ideas; open forum; and conclusion. A prime objective of the survey was to rate the importance of the 20 DMS Global PLM CSF for each of the five project phases. The importance rating scale was:

1. No Importance
2. Very Low Importance
3. Low Importance
4. Moderate Importance
5. High Importance
6. Very High Importance
7. Critical Importance

- N/A (not able to judge the importance)

The online web-based survey was established in English in QuestionPro.com (hereafter QuestionPro), a commercially available survey software tool. To manage revisions to the survey in QuestionPro, I used the naming convention of DISCxx where "DISC" signified "Doctor of

Information Systems and Communication" and "xx" was a two-digit revision number beginning at double zero, and incrementing by 1 with each change. I exported the completed English language version of the survey from QuestionPro into a MS Word document. As with the survey, revisions to the MS Word document were managed by including "Rev xx" as the suffix of the file name where "xx" was a two-digit revision number beginning at double zero, and incrementing by 1 with each change.

The MS Word document was edited to have two columns; one for English and the second for Japanese. I engaged the services of a third party professional translator who updated the MS Word document by adding the parallel Japanese language in the second column. When the Japanese language translation was completed, I updated the survey in QuestionPro by adding the Japanese language translation from the two column MS Word document.

Verification of the language translation of the survey protocol in QuestionPro began by printing a PDF of the English language version of the survey from QuestionPro, and then emailing the PDF to the third party translator. Since it was not possible to print a soft copy PDF of the Japanese Language version of the survey from QuestionPro, I gave the third party translator online access to the survey in QuestionPro. The third party translator walked through the online survey in QuestionPro and compared the Japanese language with the English language in the PDF.

Sixteen Japanese language translation changes were identified by the third party translator. To implement the changes, the third party translator emailed me a revised version of the two-column MS Word document which denoted changes by red text. I updated the Japanese language in QuestionPro and then requested the third party translator conduct a second online verification. As before, the third party translator walked through the survey in QuestionPro and compared the revised online Japanese language with the English language from the original PDF created from QuestionPro. Following the second round of online verification, no further changes were required.

The final survey protocol verification action was to have the two DMS Global facilitators complete the survey online in QuestionPro. The Japanese facilitator completed the Japanese language version of the survey. The Japanese facilitator indicated he was able to understand the survey and no changes were required. The US facilitator completed the English language version of the survey. The US facilitator indicated he was able to understand the survey and no changes were required. While the two rounds of verification produced a high-degree of confidence in the protocol, it was not possible to state the protocol was 100% accurate because completion of the survey requires interpretation by the respondent.

To ensure data resulting from the verification activities was not intermingled with the live survey data, I saved the DISC02 survey in QuestionPro as “DMSGlobalPLM” which gave the survey a web URL that incorporated the firm’s name. The online web-based survey was now ready for data collection.

Data collection.

The survey was launched by an email to the DMS Global project team on August 12, 2013, at 12:18 PM ET. QuestionPro tracked which project team members completed surveys. On August 20, 2013, I generated email reminders from QuestionPro and sent these reminders to participants who had not yet completed a survey. A review of the online survey data on August 30, 2013 found the response rate was 58.5% and the mix of national and professional culture of the response mirrored the mix of the population. While this data was adequate for the purpose of this research, after consultation with my dissertation advisor, it was decided to extend the survey due date by two weeks. Accordingly, on August 30, 2013, I generated another round of email reminders from QuestionPro and sent these reminders to participants who had not yet completed a survey. The reminder noted the extended due date of September 13. Finally, on September 5, 2013, A DMS Global PLM steering committee member sent an email to the entire survey population thanking them for their participation to date, and requesting those who had not completed the survey to set aside 30-40 minutes to complete the survey by September 13, 2013.

The survey was closed on September 13, 2013; five weeks after it had been launched. No additional surveys were completed since the review on August 30, 2013. Accordingly, the response rate remained at 58.5%. On September 16, 2013, I sent an email to the survey population thanking them for their response. Attached to the email was an MS Excel workbook file which showed the 20 PLM CSFs sorted in descending mean importance order for all five project phases. The MS Excel workbook included bar graphs of the CSF mean importance.

Data analysis.

QuestionPro provided utilities to extract survey data in both MS Excel and SPSS format. SPSS is a commercially available statistical software package from IBM. The MS Excel extract included open-ended and defined response survey questions. Conversely, the SPSS extract included only defined response questions. The quantitative analysis of survey data was executed in SPSS and preceded according to six discrete steps as follows:

1. Establish Codebook
2. Extract QuestionPro Survey Data
3. Load Data into SPSS and Apply Codebook
4. Generate and Analyze Descriptive Statistics
5. Generate and Analyze Means

6. Generate and Analyze Analysis of Variance (ANOVA)

The following sections detail each of the six data analysis steps. Validation and reliability actions taken for a given data analysis step are included in the detail section of the step. It should be noted that only Japanese and US associates completed the survey. Accordingly, the national culture analysis shall be limited to Japanese and US.

Establish codebook.

The first step in the survey data analysis was to establish a codebook. The codebook provided not only a mapping of data from QuestionPro to SPSS, but also a data dictionary that describes the following information for each variable:

- Name (of the variable)
- Type (of the data)
- Label (to be used to identify the variable in output)
- Values (which the variable may assume)
- Missing (i.e. values for the variable that should be treated as missing data)
- Measure (i.e. nominal, ordinal, scale = continuous or variable data)
- Coding Instructions (which describe how values of a variable should be manually set)

The full codebook may be found in Appendix L Table 34. Having established the codebook, survey data analysis moved to step 2.

Extract QuestionPro survey data.

The second step in the quantitative data analysis was to extract the online QuestionPro survey data. The extraction occurred on September 14, 2013 using the QuestionPro export utilities. Two files were created. First was an SPSS extract file to be imported into SPSS. The second was a MS Excel file. The worksheets MS Excel file were protected (i.e. MS Excel >

Data > Protect Sheet) so that no changes could be made to the extracted data. Both files were saved in a folder titled "20130914 Closed Survey Raw Data – No Change" where "2013" represents the year, "13" represents the month, and "14" represents the day on which the folder was created. This folder served as a backup unedited copy of the original data extracts.

Load Data into SPSS and apply codebook.

The third step in the quantitative data analysis was the loading of the QuestionPro survey data into SPSS and applying the changes required by the codebook. To assure data integrity, the folder "20130914 Closed Survey Raw Data – No Change" was copied to a folder named "20130922 Apply Codebook." The copy of the QuestionPro extract file was loaded into SPSS. I performed the following two verifications:

1. I logged into QuestionPro and confirmed the number of surveys matched the number of surveys in SPSS.
2. Next I selected the ninth survey (via random number generated in MS Excel) and visually compared the data in QuestionPro with the data in SPSS.

These actions confirmed no survey responses were lost during the export and load into SPSS, and the data loaded into SPSS matched the data in QuestionPro.

The next action was to delete incomplete survey responses in SPSS Data View. The MS Excel extract had a column titled "Response Status" with values of "Complete" and "Incomplete." I sorted the MS Excel file based on this column to isolate the incomplete survey responses. For each incomplete survey response in MS Excel I deleted the corresponding survey response in SPSS using the unique "ResponseID" number assigned by QuestionPro as the cross reference between MS Excel and SPSS. To verify no errors were made during the deletion of incomplete surveys in SPSS, I extracted the data from the SPSS Data View into an MS Excel file and compared this file with the original MS Excel file from the QuestionPro extract.

The next action was to apply the codebook changes in SPSS. This was accomplished by editing of the information in the SPSS Variable View. In some instances this required manual editing of individual data fields. In other instances, I was able to copy data from the codebook developed in MS Excel (and represented by Table 34) and paste this data into the SPSS Variable View. To verify no errors were made during the application of codebook changes, I extracted the data from the SPSS Variable View into an MS Excel file and compared this with the MS Excel codebook. The verification included both visual inspections of merged color data from the two MS Excel files and the use of the MS Excel "if function" to perform logical comparisons. To assure no inadvertent changes were made to the survey data in the SPSS Data View, I extracted this data to MS Excel and compared it with the original MS Excel extract. To preserve the codebook changes, the SPSS data file was saved in a folder titled "20131014 Survey Data After Codebook – No Changes." The survey data was now ready for analysis in SPSS.

Generate and analyze descriptive statistics.

The fourth step in the quantitative data analysis was to generate and analyze descriptive statistics. To assure data integrity, the folder "20131014 Survey Data After Codebook – No Changes" was copied to a folder titled "201301018 Survey Data Used for Analysis." I utilized the "Frequencies" functionality of SPSS to generate the following three sets of descriptive statistics:

1. Demographic Data
2. CSFs
3. Innovation

Table 35 in Appendix L contains detailed information regarding descriptive statistics.

The analysis involved the visual inspection of the descriptive statistics output. I looked for anomalies, such as histograms with values out of range (i.e. 0 and 8), and none were found. I also verified the missing data denoted by column 5 of Table 34 was handled correctly by comparing a record in SPSS with missing data, to the same record in the MS Excel QuestionPro extract. Having generated and analyze descriptive statistics, the data was now ready for analysis of means.

Generate and analyze means.

The fifth step in the quantitative data analysis was to generate and analyze CSF mean importance for the CSFs for each project phase. To accomplish this task I used the SPSS non-parametric descriptive statistics functionality. Table 2 shows a sample subset of the CSF means generated from SPSS for the project preparation phase.

Table 2. Survey – Example – CSFs Rank P1 Project Preparation

R	CSF – P1 Project Preparation	N	M	SD	Min	Max
1	01-18 TopMgmtSupport	20	6.00	0.973	4	7
2	01-02 BPRCommonProcesses	20	5.90	0.968	4	7
3	01-01 BusinessCase	20	5.80	0.951	4	7
3	01-08 GlobalIntegratedSys	20	5.80	1.056	4	7
5	01-04 ConsultSysIntegrator	20	5.65	1.268	3	7

Note. R = rank; N = number of respondents; M = mean; SD = standard deviation.

Given the first two lifecycle phases (i.e. project preparation and blueprint) are strategic in nature, it followed the strategic CSFs should have a higher mean importance in these project phases over the later phases. Accordingly, I looked for the distribution of strategic CSFs across the five project phases.

The tables of CSF means were sorted by rank, and then by CSF. This sort placed the more important CSFs at the top of the tables. Rank was determined by sequencing the CSFs from one to 20 in descending order of mean importance. The CSF with the highest mean importance was assigned rank one. The CSF with the second highest mean importance was assigned rank two. This process continued for all 20 CSFs. If two CSFs had the same mean importance, they were given the same lower rank. For example, CSF 01-01 BusinessCase and CSF 01-08 GlobalIntegratedSys have the same rank in Table 2 because they have the same mean.

Another analysis I performed was to consolidate the top five ranked CSFs into one table showing the recurrence and rank by project phase. Table 3 provides a sample subset of the top five CSFs recurrence by project phase.

Table 3. Survey – Example – CSFs Top 5 Recurrence by Project Phase

	Project Phase					
CSF	P1	P2	P3	P4	P5	Count
18 TopMgmtSupport	R = 1	R = 4				2
02 BPRCommonProcesses	R = 2	R = 1				2

Note. "R = 1" indicates the CSF had rank = 1 for the given project phase.

The motivation for limiting the number of CSFs to five was Rockart's (1979) recommendation to focus on a limited number of areas (p. 85). I examined the consolidated table for the presence of strategic CSFs in the first two lifecycle phases. I also studied the table and noted when CSFs dropped out of the top five, and when CSFs were added to the top five. Having analyzed the CSF means, the next step was to analyze the variance between national culture (Japanese and US) and professional culture (engineering and IT).

Generate and analyze ANOVA.

The sixth step in the quantitative data analysis was generation and analysis of variance (ANOVA). ANOVA is a statistical technique used to analyze the dispersion of scores around means from different groups (Nardi, 2006, p. 186). This technique indicates that the independent variable (e.g. national culture or professional culture) has an effect on the dependent variable (e.g. CSF mean importance rating) (Nardi, 2006, p. 186). ANOVA calculates a significance value, which if less than, or equal to, 0.050 implies the difference in means between groups could not have occurred merely by chance alone (Nardi, 2006, pp. 168–187).

In support of research RQ4: (How does culture change the relative importance of CSFs for global PLM IS implementations?), the following one-way ANOVAs were generated in SPSS:

1. Project Preparation Phase CSFs by National Culture
2. Project Preparation Phase CSFs by Professional Culture
3. Blueprint Phase CSFs by National Culture
4. Blueprint Phase CSFs by Professional Culture
5. Realization Phase CSFs by National Culture
6. Realization Phase CSFs by Professional Culture
7. Final Preparation Phase CSFs by National Culture
8. Final Preparation Phase CSFs by Professional Culture
9. Go Live & Support Phase CSFs by National Culture
10. Go Live & Support Phase CSFs by Professional Culture

The investigation of the ANOVAs involved searching for significant values less than or equal to 0.05. There were 22 CSFs with statistically significant differences; 5 based on national culture, and 17 based on professional culture. Additional analysis included organizing the data in tables showing the number of responses, means, and standard deviations of the CSFs by culture. From these tables, clustered column charts of means by culture, and clustered column charts by standard deviation, were created to visualize the CSFs with statistically significant differences.

Security, validity, and reliability.

Care was taken to preserve the security and privacy of all data collected. There was no hard copy data for this stage of data collection and analysis. Security of electronic data included storing this data in encrypted password protected files using the TrueCryp software (http://www.truecrypt.org/). Backup copies of the encrypted electronic data were stored in a separate physical location from the original data. The verification activities performed during this stage of data collection and analysis were noted in the data analysis section above. Reliability was assured not only through peer review, but also by the stage three focus group data collection and analysis as the focus group review incorporated the stage two survey data collection and analysis.

Stage two: survey data collection and analysis summary.

Stage two data collection and analysis involved a web-based survey of the 41 members of the DMS Global PLM project team. The survey was established in QuestionPro and available in English and Japanese languages. On August 13, 2013, the participants were invited via email to complete the survey. Reminders were sent to individuals who had not completed the survey on August 20, 2013 and August 30, 2013. A final request for participation was sent by a DMS

Global PLM steering committee member to the entire survey population on September 5, 2013. In total, the survey remained open for five weeks; closing on September 13, 2013.

There were 24 completed surveys from the population of 41 yielding a 58.5% response rate. I sent an email thanking the population for participating in the survey. The email included an MS Excel workbook which showed the 20 PLM CSFs sorted in descending mean importance order for all five project phases, and bar graphs of the CSF mean importance rating. The full data analysis involved the following six discrete steps:

1. Establish Codebook
2. Extract QuestionPro Survey Data
3. Load Data into SPSS and Apply Codebook
4. Generate and Analyze Descriptive Statistics
5. Generate and Analyze Means
6. Generate and Analyze ANOVA

The outcomes of the data analysis were incorporated into the stage three focus group data collection protocol (Appendix G).

Stage Three: Focus Group Data Collection and Analysis

Participants.

The focus group participants were the eight members of the DMS Global PLM project steering committee. This is the same population as the stage one in-depth interview data collection activities.

Rapport had been established during the stage one in-depth interview data collection. The plan for stage three data collection and analysis included two identical focus groups. This approach was chosen to minimize social pressure to participate since it will be less obvious if a steering committee member chose not to attend either focus group meeting. I utilized the two DMS Global facilitators to identify steering member availability. With availability known, I invited all eight members of the DMS Global PLM steering committee to both focus group meetings and advised they could attend either one of the two focus groups that best suited their schedule.

Protocol.

The focus group protocol (Appendix G) was created to gather data necessary to answer the research questions and employed practices used by other researchers found during the literature review. The objectives of the focus group were to present the results of this research and to discuss the findings. Given the breadth of this research and time limits on the focus group, I decided to narrow the focus group scope to concentrate on the CSFs for the implementation of a global PLM IS. Accordingly, the protocol incorporated the 20 PLM CSFs identified during the stage one in-depth interview data collection and analyses along with mean importance and the analysis of variance (ANOVA) from the stage two survey data collection and analysis. Appendix G contains the focus group protocol. Appendix K is a matrix that traces from the focus group questions to the research questions. Appendix K also provides the supporting literature for the use of focus groups in CSF research.

The focus group protocol contained ten sections: introduction; objectives and structure; review of research design; CSF importance ratings by project phase; CSF importance ratings top five CSFs; CSF analysis of variance (ANOVA) summary by culture; CSF analysis of variance (ANOVA) by national culture; CSF analysis of variance (ANOVA) by professional culture; open forum; and conclusion. Each of the ten sections included an estimated time allocation to ensure all topics were covered during the allotted two hours. The protocol also included an appendix which contained a table of the 20 CSFs, in English and Japanese, arising from the stage one in-depth interview data collection and analysis.

I developed 27 questions to be asked of the participants during the focus group meeting. These 27 questions were included in the written protocol which was sent to the participants ahead of the focus group meeting. In addition, I developed 15 probing questions based on my analysis of the data presented in the protocol. The inclusion of probing questions in the actual focus group meeting was contingent on constraints of time and the priority ranking of the probing question. The focus group questions were verified during a one-hour telephone call with my dissertation advisor.

Data collection.

On October 11, 2013, I sent invitations to the DMS Global PLM steering committee members via email for two identical focus group meetings. The first meeting was scheduled for November 7, 2013, 6:00 PM ET – 8:00 PM ET (November 8, 2013, 8:00 AM – 10:00 AM in Japan). The second meeting was scheduled for November 21, 2013 6:00 PM ET – 8:00 PM ET (November 22, 2013, 8:00 AM – 10:00 AM in Japan). Three steering committee members accepted the November 7 focus group meeting and five steering committee members accepted the November 21 focus group meeting.

The focus group duration was set at two hours to allow time for asynchronous translation between Japanese and English. The meetings were held at the DMS Global western Pennsylvania facility and utilized DMS Global's LifeSize video conferencing system. On November 3, 2013, I emailed the focus group protocol to all steering committee members. The email reminded the steering committee members of the dates of the two focus group meetings; included the focus group protocol (Appendix G) minus the probing questions; requested the participants review the attached protocol ahead of the meeting as time permitted; thanked the steering committee for their participation; and thanked the two DMS Global facilitators for their assistance in scheduling the meetings.

On the afternoon of November 7, 2013, two of the three steering committee members who initially agreed to attend the November 7 meeting declined. I called the one remaining steering committee member who agreed to participate at the November 7, focus group and advised that he would be the only steering committee member in attendance, and offered to conduct the focus group meeting one-on-one. He elected to attend the November 21, 2013 focus group meeting. As a result, only one focus group meeting was held on November 21, 2013.

The November 21, 2013 focus group meeting began at 6:00 PM ET and ended at 7:35 PM. Although all eight DMS Global PLM steering committee members had accepted this focus group meeting, only five were in attendance; two US associates and three Japanese associates. The two US associates were physically with me in a conference room located in the DMS Global facility in western Pennsylvania. The three Japanese associates (along with the interpreter and a member of the project team) were physically located in a DMS Global facility in Japan. The US and Japanese were connected via the DMS Global LifeSize video conference system which consisted of audio and two 70 inch wall-mounted video screens. One screen displayed a live video of the participants. The second screen displayed the focus group protocol. I advised the participants that I was recording the focus group meeting to ensure data accuracy. In addition to the audio recording, I scribed and maintained notes during the focus group.

All participants had printed copies of the protocol (Appendix G). To facilitate communication, I would read a few sentences from the focus group protocol, and then pause to allow for translation from English to Japanese. The interpreter typically said “Okay” to confirm the translation was complete. The flow of the focus group interaction followed the protocol which included the following eight topics:

1. Review of research design
2. CSF importance ratings by project phase
3. CSF importance ratings top five CSFs
4. CSF Analysis of variance (ANOVA) summary by culture
5. CSF Analysis of Variance (ANOVA) by national culture
6. CSF Analysis of Variance (ANOVA) by professional culture
7. Open forum
8. Conclusion

During the course of the meeting, we discussed 27 of the 27 (100%) written questions in the protocol (denoted by a prefix of "Q-" in the protocol). In addition to the written questions, we discussed 11 of the 15 (73.33%) probing questions (denoted by prefix of "P-" in the protocol). A list of the probing questions which were omitted based on time constraints and priority may be found in Appendix L.

After the focus group meeting, an associate transcribed the recording verbatim into a soft copy of the protocol. Each response was both time stamped and referenced by the unique identification number assigned to the participant. Words spoken by me (beyond reading of the in-depth interview protocol) were included within square brackets. Two verifications were performed on the transcription. First, I listened to the recording of the focus group meeting while reading the soft copy transcription and made corrections. Second, the updated transcript was sent to the participants with a request to review the transcript and advise of errors. Within a two week period, two the five (40.00%) participants responded that no changes were required. The remaining three participants did not respond.

Data analysis.

The data analysis technique used during this phase of the research was axial coding from Strauss and Corbin's (1998) work on grounded theory. They noted, "The purpose of axial coding is to begin the process of reassembling data that were fractured during open coding" (Strauss & Corbin, 1998, p. 124). The axial coding not only built on the micro-analysis grounded theory method used during stage one in-depth interview data analysis, but also aligned well with the purpose of the focus group; to present and discuss the stage one in-depth interview findings and stage two survey findings. By presenting and discussing the results with the focus group, I hoped to reassemble the stage one in-depth interview and stage two survey data to gain further understanding (Strauss & Corbin, 1998, p. 123) of global PLM system implementations, culture, and CSFs; the phenomenon of this research.

To aid the analyst in axial coding, Strauss and Corbin (1998) introduced a paradigm; "a perspective taken toward data, another analytic stance that helps systematically gather and order data in such a way that structure and process are integrated" (p. 128). Structure was defined as conditions that set the stage in which the phenomenon (problem, issue, happening, or event) is situated (Strauss & Corbin, 1998, p. 127). Process was defined as the actions/interactions taken by persons, organizations, or communities over time in response to phenomenon (Strauss & Corbin, 1998, p. 127). By relating structure and process the analyst begins to understand the complexity associated with the phenomenon. The paradigm of Strauss and Corbin (1998) was comprised of three components: conditions (i.e. structure), actions/interactions (i.e. process), and consequences (i.e. results or outcome). The flow is from conditions, to actions/interactions, to consequences. I created Figure 8 to illustrate the axial coding paradigm.

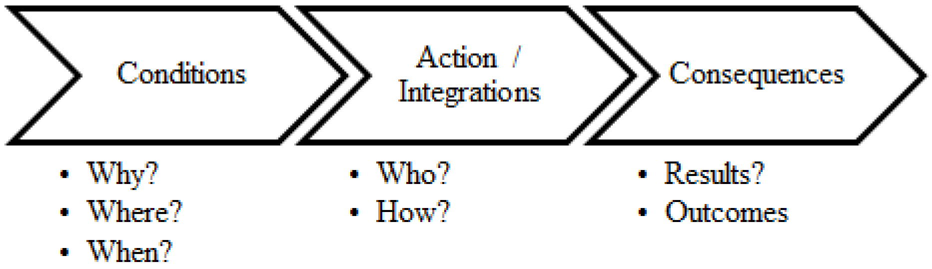

Figure 8. Focus Group - Axial Coding Paradigm

The following paragraphs describe the three components of the paradigm in more detail.

Conditions.

The first component of the axial coding paradigm was conditions. Conditions were defined as, "sets of event or happenings that create the situations, issues, and problems pertaining to a phenomenon …" (Strauss & Corbin, 1998, p. 130). Conditions help the researcher answer the questions why, where, how come, and when (Strauss & Corbin, 1998, p. 128). When considering the nature of conditions, Strauss and Corbin (1998) remarked:

> Conditions might arise out of time, place, culture, rules, regulations, beliefs, economics, power, or gender factors as well as the social worlds, organizations, and institutions in which we find ourselves along with our personal motivations and biographies. (p. 130)

To a certain degree, conditions offer insight into how and why groups, or individuals, respond to a phenomenon (Strauss & Corbin, 1998, p. 130). I saw parallels between Strauss and Corbin's (1998) framing of conditions and Hofstede's et al. (2010) framing of culture. These parallels provided another motivation for using axial coding as the analysis method for focus group data given understanding the impact of culture on the CSFs for the implementation of a global PLM IS is the problematic of this research.

Strauss and Corbin (1998) provided three labels for conditions; causal, intervening, and contextual:

1. Causal conditions usually represent sets of events or happenings that influence phenomena. (131)
2. Intervening conditions are those that mitigate or otherwise alter the impact of causal condition on phenomena. (131)
3. Contextual conditions are the specific sets of conditions (patterns of conditions) that intersect dimensionally at this time and place to create the set of circumstances or problems to which persons respond through actions/interactions. (132)

Conditions answer the questions of why, where, and when (Strauss & Corbin, 1998, p. 128). Accordingly, I reviewed the focus group transcript to identify conditions raised by the participants which answered these questions. Where possible, I labeled conditions as causal, intervening, and contextual. I did not, however, hold rigidly to this labeling. Strauss and Corbin (1998) cautioned:

> The important issue is not so much one of identifying and listing which conditions are causal, intervening, or contextual. Rather, what the analyst should focus on is the complex interweaving of events (conditions) leading up to a problem, and issue, or a happening, to which persons are responding through some form of action/interaction, with some sort of consequences. (132)

Actions / interactions.

The second component of the axial coding paradigm was actions/interactions. Actions/interactions were defined as, "… strategic or routine responses made by individuals or groups to issues, problems, happenings, or events [i.e. phenomenon] that arise under those conditions" (Strauss & Corbin, 1998, p. 128). Strategic actions/interactions are intentional acts taken in response to a problem, the consequences of which often shape the phenomenon in some manner (Strauss & Corbin, 1998, p. 133). Conversely, routine actions/interactions are habitual actions, which often follow an established protocol, taken in response to normal everyday events (Strauss & Corbin, 1998, p. 133). Actions/interactions answer the questions of who and how (Strauss & Corbin, 1998, p. 128). Therefore, I reviewed the focus group transcript for instances where participant input/feedback addressed how and by whom questions.

When considering the dynamic nature of actions/interactions, Strauss and Corbin (1998) advised:

> Actions/interactions among individuals acting in groups may or may not be in alignment, that is, coordinated. Actions/interactions evolve over time as person define or give meaning to situations. Under some conditions, alignment does not occur, and the situation turns into one of conflict and eventually breaks down completely. (p. 134)

This advice from Strauss and Corbin (1998) foreshadowed the impact of culture on process when they observed persons give meaning to situations and conditions (which encompass time, place, culture, rules, regulations, beliefs, economics, power, gender factors social worlds, organizations, and institutions), and different meanings given to situations and conditions may result in misalignment and conflict.

Consequences.

The third component of the axial coding paradigm was consequences. Consequences were defined as, "… the outcomes of actions/interactions" (Strauss & Corbin, 1998, p. 128). Consequences may be: intended or unintended; singular or many; immediate or cumulative; narrow or widespread; visible to others but not to self; visible to self but not to others; and varied in duration (Strauss & Corbin, 1998, p. 134). Strauss and Corbin (1998) note, "Consequences are represented by questions as to what happens as a result of those actions/interactions or the failure of persons or groups to respond to situations [or conditions] by actions/interactions, which constitutes an important finding in and of itself" (p. 128). Accordingly, I reviewed the focus group transcript for instances where participant input/feedback indicated outcomes of actions/interactions taken in response to conditions.

After concluding their guidance on the axial coding paradigm (conditions leading to actions/interactions leading to consequences), Strauss and Corbin (1998) returned to the primary purpose of axial coding; reassembling the data that was fractured during open coding to develop understanding and explanatory schemes not only to guide behavior but also to provide some level of predictability for events (Strauss & Corbin, 1998, pp. 123–124). Specifically, the paradigm yields relationships between conditions, actions/interactions, and consequences (Strauss & Corbin, 1998, p. 135). They called these relationships (which explain the what, why, where, and how of a phenomenon) "hypotheses" (Strauss & Corbin, 1998, p. 135). Strauss and Corbin (1998) encouraged researches to develop hypothesis that are grounded in the data while cautioning, "Although hypotheses are derived from data, because they are abstractions (i.e., statements make at the conceptual level rather than at the raw data level), it is important that these be validated and further elaborated through continued comparison of data incident to incident" (Strauss & Corbin, 1998, p. 135). Consequently, the final analysis activity performed on the focus group data was to identify preliminary hypotheses resulting from the data.

Security, validity, and reliability.

Care was taken to ensure the security, and privacy of all data collected. Hard copy data was stored in a locked file. Security of electronic data included storing this data in encrypted password protected files using the TrueCryp software (http://www.truecrypt.org/). Backup copies of the encrypted electronic data were stored in a separate physical location from the original data.

As noted in the data collection section above, two verifications were performed on the focus group transcription. First, I listened to the recorded focus group meeting while reading the transcription and made corrections. Second, the updated transcript was sent to the participants with a request to review the transcript and advise of errors. Two of five participants responded. Both found no errors in the transcript.

Stage three: focus group data collection and analysis summary.

Stage three data collection and analysis was a focus group with the DMS Global PLM steering committee on November 21, 2013. Five of the eight (two US and three Japanese) steering committee members participated in the focus group. Video conferencing and asynchronous translation between English and Japanese were employed for the duration of the meeting which lasted one hour and 35 minutes. The flow of the focus group interaction followed the protocol. A verbatim transcript of the focus group was created and verified via member checking. Data analysis followed Strauss and Corbin's (1998) axial coding paradigm which included reviewing the focus group transcript to identify conditions, actions/interactions, consequences, and preliminary hypotheses.

Chapter 3 Methodology Summary

Stage one data collection and analysis focused on in-depth interviews with the eight members of the DMS Global PLM steering committee. A key outcome of stage one was the identification of 20 CSFs for the implementation of a Global PLM IS. These CSFs were incorporated into the stage two data collection and analysis.

Stage two data collection and analysis encompassed a web-based survey of the DMS Global PLM project team. There were 24 completed surveys from the population of 41 yielding a 58.5% response rate. The results of the stage two survey data analysis were incorporated into the stage three focus group data collection and analysis.

Stage three data collection and analysis was a focus group with the DMS Global PLM steering committee. Five (three from Japan and two from the US) of the eight steering committee members attended the focus group meeting. The key outcomes of the focus group were modification to the top five ranked CSFs by project phase, and the identification of relational statements, or hypothesis (Strauss and Corbin, 1998, p. 135), that led the development of a preliminary theoretical framework integrating PLM IS implementation, culture, and CSFs.

Chapter 4 Results

Introduction

DMS Global, a multinational designer, manufacturer, and servicer of engineer-to-order heavy industrial equipment had disparate engineering IS and processes that created a barrier to enterprise growth. In response, the firm launched a project in 2010 to implement a common enterprise-wide PLM IS. In and of itself, the implementation of a PLM IS was a complex and challenging technological and social endeavor. For DMS Global, the complexity and challenge was further compounded by the presence of multiple cultures. Unfortunately, the academic literature was largely silent and offered little empirical or theoretical help. To state the problem succinctly, there was no theoretical framework integrating global PLM IS implementations, culture, and CSFs.

The purpose of this research was twofold. The primary purpose of this research was to explore the challenges associated with global PLM IS implementations through the holistic analysis of the single instrumental DMS Global case (Creswell, 2007, p. 74, 75). The secondary aim was to develop a preliminary theoretical framework that modeled the process of implementing a global PLM IS in an engineer-to-order multi-cultural environment similar to DMS Global.

The lack of a theoretical framework integrating global PLM IS implementations, culture, and CSFs led to the formation of five research questions: To answer the research questions, this case study research employed mixed methods and progressed through three-stages of data collection and analysis as indicated by Figure 5. Stage one in-depth interview data collection and analysis focused on RQ1, RQ2, and RQ3. Stage two survey data collection and analysis incorporated the 20 PLM CSFs from stage one and considered RQ1, RQ2, RQ3, and RQ4. Stage three focus group data collection and analysis incorporated the stage two quantitative data analysis and addressed RQ3, RQ4, and RQ5.

Protocols were developed for each stage of data collection and analysis to gather the data necessary to answer the research question. Appendices E, F, and G document the protocols while Appendices I, J, and K trace, or link the protocol questions to both the literature and the research questions. The outcomes (findings or results) of each stage of data collection and analysis were used in the subsequent stage of data collection and analysis yielding a theoretical framework that is grounded in the data (Creswell, 2007, p. 64; Strauss & Corbin, 1990, p. 23).

Hence the problem statement informed the purpose of the study, which informed the research questions, which informed the three-stage mixed methods research design. To promote coherence and consistency, the results are presented using the same interrelated structure. Specifically, the results are presented by stage of data collection and analysis. Within each stage, participant demographics are presented first. Following the demographics, results are organized by the research question. A mix of textual descriptions, direct quotes from participants, tables, and figures were employed to present results. The following convention will be used for participant quotations:

- "DI, ID-xx, p. xx" where "DI" means in-depth interview, "ID-xx" means transcript from unique participant ID number xx, and "p. xx" means page number xx.
- "SU, ID-xx, q. xx" where "SU" means survey, "ID-xx" means survey from unique participant ID number xx, and "q. xx" means response to survey question xx. The convention of "q. xx" was adopted given survey responses do not have page numbers.

- "FG, ID-xx, p. xx" Where "FG" means focus group, "ID-xx" means focus group transcript comment from unique participant ID number xx, and "p. xx" means page number xx.

Care was taken to note both anticipated (expected) and unanticipated (unexpected) findings based not only on the literature review, but also on my 27 years of professional experience. Each stage of data collection and analysis results ends with a brief summary which transitions to the subsequent stage by noting how the findings from the preceding stage enlighten the succeeding stage.

Stage One: In-Depth Interview Results

The in-depth interviews gathered data to answer the following research questions (Appendix E, Appendix I):

RQ1: How does vision of success for global PLM IS vary by culture?

RQ2: How do goals for global PLM IS vary by culture?

RQ3: What are the CSFs for global PLM IS implementation?

The results for the demographic questions are presented first, followed by the results for the research questions.

Participant demographics results.

The in-depth interview population was the eight member DMS Global PLM project steering committee. All eight steering committee members (100%) participated in in-depth interviews. All steering committee members were male (100%). The demographic section of the in-depth interview protocol had ten questions:

1. Please tell me the country in which you were born.

2. Please select the one most appropriate answer from the following list that best describes your current age.
3. Please select the one most appropriate answer from the following list that best describes your highest level of education.
4. Please describe your major, or area of study, for your higher education. If you have more than one major, or area of study, then please describe.
5. Please select the one most appropriate answer from the following list that best describes your total number of years of work experience.
6. Please tell me your current job title in DMS Global.
7. Please select the one most appropriate answer from the following list that best describes the number of years you have worked for DMS Global.
8. Please select the one most appropriate answer from the following list that best describes the total amount of time you have been involved in the DMS Global PLM project.
9. Please select the one most appropriate answer from the following list that describes the current phase of your PLM project.
10. If you have been involved in past information system implementation projects, then please briefly describe the projects and your role.

Figure 20 through Figure 29 in Appendix M display the results of the ten demographic questions from the stage one in-depth interviews.

Participant demographics results summary.

A review of the demographic data led to the following observations. In-depth interviews were conducted with all eight members (100%) of the steering committee participated. The national culture mix was 38% Japanese and 62 % US. Seven of eight (88%) participants were age 51 or older. Seven of eight (88%) participants had 31 years or more of work experience. Five of eight (62%) participants had 31 years or more work experience at DMS Global. Four of eight (50%) had no prior IS implementation experience.

Having analyzed and summarized demographic results, I turned to the analysis of RQ1: PLM vision of success.

RQ1: PLM vision of success results.

RQ1: How does vision of success for global PLM IS vary by culture? The results for RQ1: came from the open coding of the in-depth interview transcripts which employed micro analysis from Strauss and Corbin (1998, p. 57) and proceeded in four steps as indicated by Figure 6. The open coding of the in-depth interview transcripts found 38 unique categories for vision of success as indicated by Table 4. Japan is abbreviated as "JP" in column headings. The data in Table 4 was sorted by: Total (descending), JP (descending), US (descending), and Vision of Success Theme (ascending). The integer values in Table 4 represent the number of participants who raised the vision of success category during their interview. There were three Japanese in-depth interview participants and five US in-depth interview participants for a total of eight in-depth interview participants. Accordingly, Japanese % is calculated as Japanese divided by 3, US % as US divided by 5, and Total % as Total divided by 8.

Table 4. In-depth Interviews – National Culture – Vision of Success Themes

	JP		US		Total	
Vision of Success Theme	N	%	N	%	N	%
Integrate Japan & US	3	100	5	100	8	100
Productivity Increase	2	67	4	80	6	75

	JP		US		Total	
Vision of Success Theme	N	%	N	%	N	%
3D CAD Models	2	67	2	40	4	50
Global Service Access	2	67	2	40	4	50
Global Resource Sharing	1	33	3	60	4	50
Customer Documents	2	67	1	20	3	38
Single Source of Product Data	2	67	1	20	3	38
2D CAD Drawings	1	33	2	40	3	38
Common Process	1	33	2	40	3	38
Process Discipline	1	33	2	40	3	38
Adaptable PLM Foundation			3	60	3	38
Full Product Lifecycle			3	60	3	38
Management of Product Data	2	67			2	25
No Quantifiable Vision Goals	2	67			2	25
Engineering User	1	33	1	20	2	25
ERP Integration	1	33	1	20	2	25
Internal Documents	1	33	1	20	2	25
Reuse of Information	1	33	1	20	2	25
Engineering Change Process			2	40	2	25
User Satisfaction			2	40	2	25
Workload Management			2	40	2	25
Access for View Only Users			1	20	1	13
Accurate			1	20	1	13
Bills of Material in PLM			1	20	1	13
Customer Integration			1	20	1	13

	JP		US		Total	
Vision of Success Theme	N	%	N	%	N	%
Customer Productivity Increase			1	20	1	13
Customer Satisfaction			1	20	1	13
Future: Customer Proposal			1	20	1	13
Future: Customer Quotation			1	20	1	13
Future: Data Driven Management			1	20	1	13
Future: R&D Integration			1	20	1	13
On-Time			1	20	1	13
Retire Legacy PLM Systems			1	20	1	13
Robust PLM Functionality			1	20	1	13
Supplier Documents			1	20	1	13
Tested System			1	20	1	13
Training			1	20	1	13
View and Use Feedback			1	20	1	13
Total Themes = 38	25	n/a	57	n/a	82	n/a

Of the 38 themes for vision of success, 14 (36.84%) were identified by both Japanese and US participants, two (5.26%) were identified only by Japanese participants, and 22 (57.89%) were identified only by US participants.

I developed the following vision of success statement for the DMS Global PLM project from the data in Table 4:

The PLM IS provides a single integrated source of global product data for DMS Global. Common robust worldwide processes are utilized in a disciplined manner to increase *productivity and on-time delivery. The functionality encompasses the full product lifecycle (initial concept to retirement) and includes: customer documents, supplier documents, internal documents, 2D CAD drawings, 3D CAD models, engineering change management, bills of material, workload management, global resource sharing, and ERP integration. Users, customers, and suppliers are highly satisfied. The system provides a solid foundation for current needs and may be adapted to support future growth and integration.*

Having presented the vision of success results for both national and professional culture, the following section summarizes the findings and considers anticipated and unanticipated results.

RQ1: PLM vision of success results summary.

RQ1: How does vision of success for global PLM IS vary by culture? An analysis of the cultural distance (Table 1) from Hofstede et al. (2010) indicates the largest areas of cultural difference are long-term orientation, followed by uncertainty avoidance, and then individualism. Consequently, I would expect to find differences in the Japanese and US vision of success in these areas. Each of these three cultural dimensions (long-term orientation, uncertainty avoidance, and individualism) will be explored in the following paragraphs respectively.

Long-term orientation was defined by Hofstede et al. (2010) as, "… the fostering of pragmatic virtues oriented towards future rewards, in particular perseverance, thrift, and adapting to changing circumstances" (p. 239). In Table 1, Japan has a high long-term orientation score (88) and the US has a low long-term orientation score (26). Thus, I expected the Japanese vision of success to be more oriented towards future rewards than the US statement. When I examined the vision of success themes in Table 4, I found a stronger long-term orientation in the US vision than the Japanese vision. For example, the US vision of success included themes for "Adaptable PLM Foundation, Full Product Lifecycle, Future: Customer Proposal, Future: Customer Quotation, Future: Data Driven Management, and Future R&D Integration." The Japanese vision of success did not have these long-term themes. This was an unanticipated result. In addition, the Japanese vision of success was primarily focused on short-term internal PLM processes with one external theme for "Customer Documents." The US vision of success was more broadly focused on long-term integration with customers and suppliers, and added themes for "Customer Integration, Customer Productivity Increase, Customer Satisfaction, and Supplier Documents."

Uncertainty avoidance was defined by Hofstede et al. (2010) as, "… the extent to which the members of a culture feel threatened by ambiguous or unknown situations" (p. 191). In Table 1, Japan has a high uncertainty avoidance score (92) and the US has a mid-range uncertainty avoidance score (46). Therefore, I expected the Japanese vision of success to express a desire to avoid uncertainty. This anticipated result was met as two Japanese associates communicated they were unable to quantify the PLM vision of success as indicated by the following quotes:

- However, we don't have any specific number for goals since it's not possible to quantify. (DI, ID-01, p.11)
- Having said that, it's very difficult to try to, to give it numerical values. (DI, ID-09, p. 11)

The reluctance to provide quantifiable measures for the vision of success was captured by theme "No Quantifiable Vision Goals" in Table 4. As anticipated, the US in-depth interview participants did not express the same concern with uncertainty.

Individualism was defined by Hofstede et al. (2010) as, "…societies in which the ties between individuals are loose: everyone is expected to look after him- or herself in his or her immediate family" (p. 92). In Table 1, the US has a high individualism score (91) and Japan has a mid-range individualism score (46). Hence I expected more diversity in the vision of success for the US, and less variation from the Japanese. An analysis of vision of success categories in Table 4 confirmed this anticipated result. Specifically, of the 38 themes for vision of success, 22 themes (57.89%) were identified only by US participants and two themes (5.26%) were identified only by Japanese participants. Further, within the US participants, the themes were more diverse. For example, the US had 23 of 36 (63.89%) themes identified by only one participant. The Japanese participants had 8 of 16 (50.00%) themes identified by only one participant.

Having analyzed and summarized the results for RQ1: PLM vision of success, I turned to the analysis of RQ2: PLM goals.

RQ2: PLM goals results.

RQ2: How do goals for global PLM IS vary by culture? As with RQ1, the results for RQ2: came from the open coding of the in-depth interview transcripts which employed micro analysis from Strauss and Corbin (Strauss & Corbin, 1998, p. 57) and proceeded in four steps as indicated by Figure 6. The open coding of the in-depth interview transcripts found 36 unique themes for goals as indicated by Table 5. Japan is abbreviated as "JP" in column headings. The data in Table 5 was sorted by: Total (descending), JP (descending), US (descending), and Goal Theme (ascending). US % is calculated as US divided by 5, Japan % as Japan divided by 3, and Total % as Total divided by 8.

Table 5. In-depth Interviews – National Culture – Goal Themes

	JP		US		Total	
Goal Theme	N	%	N	%	N	%
Timely Implementation	1	33	4	80	5	63
Map & Gap Japan to US	2	67	2	40	4	50
Business Process Reengineering (BRP) Common Process	1	33	3	60	4	50
Timeline (Schedule)	2	67	1	20	3	38
Design Engineering Change Process	1	33	2	40	3	38
Training (Initial & Ongoing)			3	60	3	38
Analyze AS IS Japan Processes	2	67			2	25
Budget (Cost)	2	67			2	25
Design CAD Process	2	67			2	25
Design TO BE Japan Processes	2	67			2	25
Design Customer Document Process	1	33	1	20	2	25
Milestone Management	1	33	1	20	2	25
Testing	1	33	1	20	2	25
User Input & Satisfaction	1	33	1	20	2	25
Data Conversion			2	40	2	25
Implement PLM in Japan First			2	40	2	25
Phased Implementation Strategy			2	40	2	25
Consultant (System Integrator)	1	33			1	13
Eliminate Waste	1	33			1	13
EPR Integration	1	33			1	13
Global Service Search	1	33			1	13

	JP		US		Total	
Goal Theme	N	%	N	%	N	%
Improve Quality	1	33			1	13
Process Discipline	1	33			1	13
Productivity Increase	1	33			1	13
Risk Management (Quality Assure)	1	33			1	13
Configure PLM to Meet Needs			1	20	1	13
Constant Improvement			1	20	1	13
Design BOM Process			1	20	1	13
Design Internal Document Process			1	20	1	13
Design Supplier Document Process			1	20	1	13
Design Task Management Process			1	20	1	13
Formal PLM Procedures			1	20	1	13
Goals & Objectives (Scope)			1	20	1	13
Implement PLM in US Second			1	20	1	13
Minimize Disruption at Go Live			1	20	1	13
View Only Access			1	20	1	13
Total themes = 36	27	n/a	36	n/a	63	n/a

Of the 36 themes for goals, nine (25.00%) were identified by both Japanese and US participants, 12 (33.33%) were identified only by Japanese participants, and 15 (41.67%) were identified only by US participants.

Having presented the goal results for national culture, the following section summarizes the findings and considers anticipated and unanticipated results.

RQ2: PLM goals results summary.

RQ2: How do goals for global PLM IS vary by culture? As with RQ1, anticipated and unanticipated results were identified by analyzing the goal themes from RQ2: with respect to Hofstede's et al. (2010) cultural dimensions of long-term orientation, uncertainty avoidance, and individualism (Table 1). These three dimensions were chosen because they represented the largest difference in index scores between the Japanese and the US. Each of the three cultural dimensions will be explored in the following paragraphs respectively.

Regarding long-term orientation, I expected the Japanese goals to be more oriented towards future rewards than the US goals. When I examined the goal themes in Table 5, however, I found a stronger long-term orientation in the US goals than the Japanese goals. For example, the US goals included categories for "Implement PLM in Japan First, Implement PLM in US Second, Phased Implementation Strategy, and Training (Initial & Ongoing)." The Japanese goals did not appear to extend beyond their current PLM implementation project. This was an unanticipated result.

To counter this unanticipated result, Hofstede's et al. (2010) definition of long-term orientation did include references to thrift (p. 239). The data suggests the Japanese are more orientated towards thrift as their goal categories included "Budget (Cost), Eliminate Waste, and Productivity Increase." While the US goals did include one reference to "Constant Improvement" which is similar to the Japanese goal of "Eliminate Waste," the US goals seemed less oriented toward thrift. This was an expected result.

Regarding uncertainty avoidance, I expected the Japanese goals to express a desire to avoid uncertainty. This anticipated result was met as the Japanese goals included "Budget (Cost), Improve Quality, Process Discipline, and Risk Management (Quality Assure)." These goals are oriented toward minimizing what Hofstede et al. (2010) termed, "… ambiguous or unknown situations" (p. 191). The following quotes from Japanese participants support these results:

- So based on the result of our study, we determine the detail schedule as well as a final budget. (DI, ID-01, p. 13)
- And when it's implemented, we need to extract the possible business risks and agree, management and users will need to agree on them. And based on this, decide on the detail schedule, budget and what sort of goals. (DI, ID-09, p.13)

The US, however, had similar uncertainty avoidance goals; "Formal PLM Procedures, and Minimize Disruption at Go Live." This was an unanticipated result.

Regarding individualism, I expected more diversity in the goals for the US, and less variation from the Japanese. An analysis of the goal themes in Table 5 did not support this expectation. With 12 goal categories unique to Japanese participants and 15 goal categories unique to US participants, it appeared both groups were equally diverse in their goal statements.

Having analyzed and summarized the results for RQ2: PLM goals, I turned to the analysis of RQ3: PLM CSFs.

RQ3: PLM CSFs results.

RQ3: What are the CSFs for global PLM IS implementation? The results for RQ3: came from the open coding of in-depth interview transcripts which employed micro analysis for Strauss and Corbin (1998, p. 57). The micro analysis for RQ3: proceeded in ten steps as indicated by Figure 7. The results will be presented in three groups: first steps one through four, second steps five through eight, and third steps nine through ten.

Steps one through four of the open coding process yielded the 20 preliminary PLM CSFs listed in Table 6 which had 176 references in the in-depth interviews.

Table 6. In-depth Interviews – Open Coding Steps 1 to 4 – Preliminary PLM CSFs

Preliminary CSFs for Global PLM IS Implementation	References
1. Business Case (Business Value)	14
2. Business Process Reengineering (Common Processes)	19
3. Change Management (Cultural Awareness)	6
4. Consultant (System Integrator)	10
5. Budget (Cost)	5
6. Customer Satisfaction (Involvement)	7
7. Data Conversion (Analysis)	3
8. Global Integrated System	23
9. Goals & Objectives (Scope)	17
10. Implementation Strategy (Methodology)	6
11. Past Experience (Lessons Learned)	2
12. PLM System Evaluation and Selection	5
13. Project Management (Monitoring)	7
14. Project Team (Resources)	6
15. Risk Management & Quality Assurance	7
16. Timeline (Schedule)	6
17. Testing (Validation)	4
18. Top Management Support (Steering Committee)	9
19. Training and Education	13
20. User Satisfaction (Involvement)	7

Steps five through eight of the open coding process focused on identifying CSFs from the academic literature. The following seven academic sources (sorted in ascending publication date order) provided summarized lists of CSFs:

1. Somers and Nelson, 2001
2. Soliman et al., 2001
3. Plant and Willcocks, 2007
4. Finney and Corbett, 2007
5. García-Sánchez and Pérez-Bernal, 2007
6. Frimpon, 2011
7. Olszak and Ziemba, 2012

The CSFs from the academic literature were consolidated into a Microsoft Excel workbook in step 6 of the open coding process, aligned in step 7 of the open coding process, and then grouped into categories in step 8 of the open coding process. I found 48 unique CSFs from the literature review which are listed in Table 7.

Table 7. In-depth Interviews – Open Coding Steps 5 to 8 – CSFs from Literature

CSF from Academic Literature
1. Budget / Cost Planning and Management
2. Strong Business Case / Sound Basis for Project
3. Business Process Reengineering
4. Effective Change Management
5. Consultant Selection and Relationship
6. Customer Involvement
7. Data Analysis & Conversion
8. Clear Goals & Objectives

CSF from Academic Literature
9. Implementation Strategy & Timeframe
10. Past Experience (learning from)
11. Careful PLM Package Selection
12. Project Management
13. Project Team Competence
14. Risks Addressed / Assessed / Managed
15. System Testing
16. Realistic Schedule
17. Top Management Commitment & Support
18. Training & Job Redesign
19. User Involvement
20. Architecture Choices
21. Dedicated Resources
22. Design Office Services & Support Functions
23. Different Viewpoints (appreciating)
24. Education On New Business Processes
25. Effective Monitoring / Control
26. Empowered Decision Makers
27. Environmental Influences
28. Good Communication / Feedback
29. Good Leadership
30. Interdepartmental Cooperation
31. IT Infrastructure
32. Legacy System Consideration

CSF from Academic Literature
33. Management of Expectations
34. Managing Cultural Change
35. Minimal Customization
36. Partnership with Vendor
37. Planned Close Down / Review / Acceptance of Possible Failure
38. Political Stability
39. Project Champion
40. Project Size (large) / Level of Complexity (high) / Number of People Involved (too many) / Duration (over 3 years)
41. Security of CAD / CAM Interface
42. Sufficient / Well Allocated Resources
43. Team Morale and Motivation
44. Troubleshooting / Crises Management
45. Use of Steering Committee
46. Use of Vendors' Tools
47. User Friendliness of PLM Systems
48. Vendor Support

Steps nine and ten of the open coding process produced a final list of CSFs for Global PLM IS implementation. Specifically, step nine adjusted the names of the 20 PLM CSFs based on the academic literature CSFs, and step ten added a longer description to each of the 20 PLM CSFs. The longer description was an amalgamation of DMS Global properties from Table 6, CSF descriptions from the academic literature, my professional experience, and my institutional knowledge of DMS global. It was important to have CSFs which were intelligible to both

Japanese and US DMS Global steering committee and project team members to aid data collection accuracy. Steps nine and ten of the open coding process produced the 20 final PLM CSFs documented in Table 8.

Table 8. In-depth Interviews – Open Coding Steps 9 to 10 – Final PLM CSFs

CSFs for Global PLM IS Implementation
1. Business Case: Develop a business case that identifies how the PLM system will provide value through effective, efficient processes that increase revenue, profit, and productivity while allowing for continuous improvement.
2. Business Process Reengineering (Common Processes): Reengineer DMS Global processes to utilize common PLM system best practices. Minimize complexity and software customization.
3. Change Management: Develop a comprehensive, culturally sensitive, change management plan that facilitates the implementation of the PLM system.
4. Consultant (System Integrator): Identify, evaluate, and select a PLM consulting firm that is not only technically competent, but also understands the DMS Global business and is willing to work collaboratively.
5. Budget (Cost): Identify the project costs, allocate the necessary funds, and monitor spending against budget.
6. Customer Satisfaction: Collaborate with customers to understand their requirements, and then implement a PLM system that will satisfy their needs.
7. Data Conversion: Analyze data to assure an accurate and complete migration of data from legacy systems to the PLM system

CSFs for Global PLM IS Implementation
8. Global Integrated System: Implement the PLM system in a manner that provides one global engineering system that can be used by all DMS Global locations and business units (Engineered Products, Industrial Products, and Global Service). Make certain the PLM system is integrated with Enterprise Resource Planning (ERP) systems and Microsoft Excel.
9. Goals & Objectives (Scope): Identify a prioritized and limited list of clearly defined measurable goals and objectives for the PLM system.
10. Implementation Strategy: Establish an implementation strategy that deploys the PLM system in a phased approach.
11. Past Experience (Lessons Learned): Review past experience with PLM system implementation and apply lessons learned.
12. PLM System Evaluation & Selection: Identify, evaluate, and select the PLM system that not only meets short-term information and process needs, but also provides a foundation for long-term global growth.
13. Project Management: Provide for the ongoing management (planning, monitoring, and controlling) of the scope, schedule, resources, cost, and risk of the PLM system implementation.
14. Project Team (Resources): Assemble a team of technically competent individuals who understand the engineering needs of DMS Global and who are willing to work on the PLM system implementation. Give the team adequate time to work on the project.

CSFs for Global PLM IS Implementation
15. Risk Management (Quality Assurance): Identify and assess risks. Establish a risk management plan that assures the quality of the PLM system implementation.
16. Timeline (Schedule): Create a realistic implementation timeline, monitor progress, and adjust as necessary.
17. Testing: Create and execute a system test plan, including simulated real-world test cases, that validates the PLM system meets expectations.
18. Top Management Support: Assemble a global team of top managers (steering committee) who are committed to the successful implementation of the PLM system. The team establishes goals and objectives, monitors progress, allocates human and financial resources, and resolves conflicts.
19. Training: Provide initial (short-term) and ongoing (long-term) high-quality training so that users know how to do their jobs in the PLM system. Support the training with good documentation and manuals.
20. User Satisfaction: Collaborate with users to understand their requirements, and then implement a PLM system that will satisfy their needs.

The following section summarizes the findings and considers anticipated and unanticipated results.

RQ3: PLM CSFs results summary.

RQ3: What are the CSFs for global PLM IS implementation? I expected CSFs for global PLM IS implementation identified by DMS Global to be a subset of the consolidated list of CSFs from the academic literature (Table 8). The reason for this expectation is the maturity of the of the CSF academic literature; with the concept of CSFs being introduced by Daniel (1961) in 1961 and popularized by Rockart (1979) in 1979. This expectation was met with one exception; CSF 8 Global Integrated System. I did not find a CSF directly related to the desire for a single integrated source of global product data in the academic literature.

RQ3: PLM CSFs was the final research question addressed by the stage one in-depth interview data collection and analysis. Hence the following section summarizes the stage one in-depth interview data collection and analysis results.

Stage one: in-depth interview results summary.

Stage one data collection encompassed in-depth interviews with the DMS Global PLM steering committee and focused on RQ1, RQ2, and RQ3. All eight steering committee members participated. The in-depth interview population was predominantly (62%) US. A large proportion of the participants (88%) were 51 years or older and had 31 years or more work experience. A majority of the participant population (62%) had invested 31 years or more of their career working for DMS Global. One half (50%) of the participant population had no prior IS implementation experience.

RQ1: How does vision of success for global PLM IS vary by culture? The data let to the following vision of success:

The PLM IS provides a single integrated source of global product data for DMS Global. Common robust worldwide processes are utilized in a disciplined manner to increase productivity and on-time delivery. The functionality encompasses the full product lifecycle (initial concept to retirement) and includes: customer documents, supplier documents, internal documents, 2D CAD drawings, 3D CAD models, engineering change *management, bills of material, workload management, global resource sharing, and ERP integration. Users, customers, and suppliers are highly satisfied. The system provides a solid foundation for current needs and may be adapted to support future growth and integration.*

As expected the Japanese associates were more risk-adverse than their US counterparts and the US participants were more individualistic than the Japanese. An unanticipated result was a stronger long-term orientation regarding PLM from the US over the Japanese.

RQ2: How do goals for global PLM IS vary by culture? The open coding of the in-depth interview transcripts found 36 unique themes for goals. As anticipated, the Japanese were risk-adverse. Similarly, the US steering committee members were also risk-adverse; which was an unanticipated result. As expected, the US associates were individualistic. What was not expected, however, was the individuality demonstrated in the Japanese goals. Another unexpected result was the US associates had a longer-term orientation than their Japanese colleagues.

RQ3: What are the CSFs for global PLM IS implementation? The micro analysis of the in-depth interview transcripts yielded 20 PLM CSFs. As anticipated, the PLM CSFs were a subset of the ERP CSFs. The 20 PLM CSFs became the primary input to the stage two survey data collection and analysis.

Stage Two: Survey Results

The survey gathered data to answer the following research questions (Appendix F, Appendix J):

RQ1: How does vision of success for global PLM IS vary by culture?

RQ2: How do goals for global PLM IS vary by culture?

RQ3: What are the CSFs for global PLM IS implementation?

RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation?

Accordingly, the survey protocol (Appendix F) was organized in eight sections as presented in the Methodology chapter and Appendix F.

The survey population included national culture (Japanese and US) and professional culture (engineering and IT). It should be noted, the sample size (n=24) was not large enough to analyze second order cultural effects. For example, I was not able to analyze differences between Japanese engineers and Japanese IT associates. The results for the demographic questions are presented first, followed by the results for the research questions.

The results for RQ3: and RQ4: came from the participant's rating of CSF importance on a 1 to 7 Likert scale for each of the five project phases. Consequently, the results for RQ3: and RQ4: were presented in tables of PLM CSFs sorted by rank, and then by PLM CSF name. This sort placed the more important CSFs at the top of the tables. Rank was determined by sequencing the CSFs from one to 20 in descending order of mean importance. The CSFs with the highest mean importance was assigned rank one. The CSF with the second highest mean importance was assigned rank two. This process continued for all 20 CSFs. If two CSFs had the same mean importance, they were given the same lower rank.

Participant demographics results.

The survey population was the 41 members of the DMS Global PLM project team. From the population of 41, 24 completed surveys were obtained yielding a response rate of 57.14%. Six surveys were started but not completed generating a completion rate of 80% (24 surveys completed divided by 30 surveys started). Only completed surveys were included in the results.

The survey population included Japanese and US associates of DMS Global, and third-party service providers / systems integrators engaged on this project. Figure 9 shows the mix of national culture (Japanese and US) for both the survey population and response.

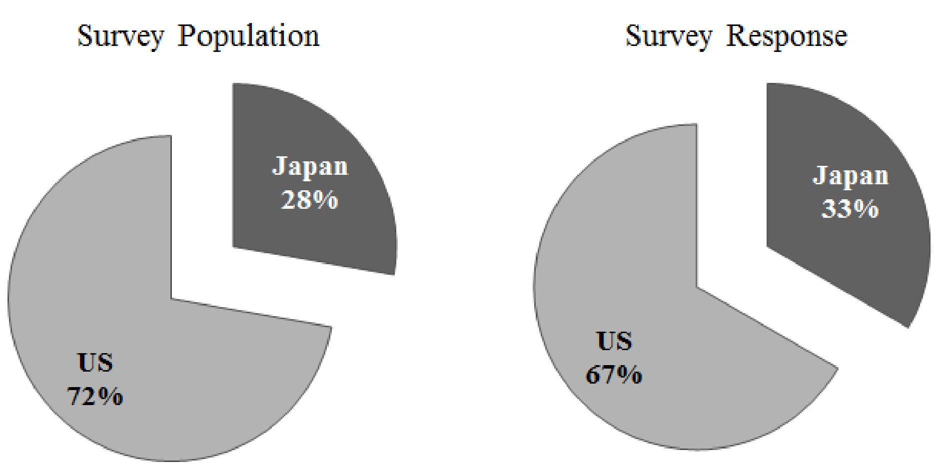

Figure 9. Survey – National Culture – Population & Response Mix

The survey response mirrored the mix survey population for the dimension of national culture with a variance of five percentage points. Similarly, Figure 10 shows the mix of professional culture (engineering and IT) for both the survey population and response.

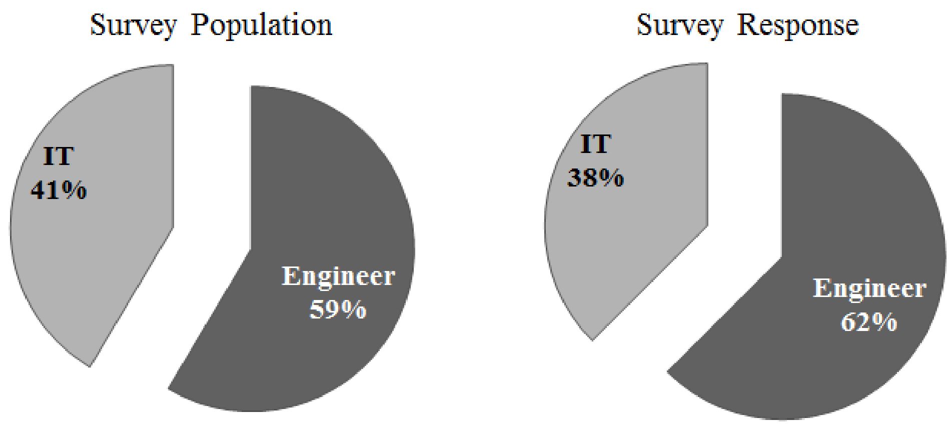

Figure 10. Survey – Professional Culture – Population & Response Mix

The survey response reflected the distribution of the survey population for professional culture with a difference of three percentage points.

Participant demographics results summary.

A review of the demographic data led to the following observations. The national culture mix was 33.30% Japanese and 66.70% US. The professional culture mix was 62.50% engineer and 37.50% IT. The respondents were 81.70% male and 8.3% female. The largest portion (29.20%) of the respondents was age 41 to 45 years of age, followed by (25.00%) age 51 or more. The majority of respondents (79.20%) held bachelor (41.70%) or master (37.50%) degrees. Similarly, the majority of respondents (83.30%) had 16 years or more of work experience. One half (50.00%) of the respondents had invested 16 years or more of their careers working for DMS Global. The number of months working on the PLM project varied. The majority of respondents (70.80%) indicated the current phase of their PLM project was in the Blueprint, Realization, or Final Preparation phase. Finally, despite the relatively large duration of work experience, only 20.83% of the respondents had any prior experience with the implementation of IS.

To summarize, the mix of national and professional culture of the response was representative of the population. The respondents were:

- Predominantly male (81.70%)
- Held baccalaureate or post-baccalaureate degree (79.20%)
- Had relatively long work experience (83.30% having 16 years or more work experience)
- Invested 16 years or more of their work experience with DMS Global (50.00%)

There was some confusion regarding the current project phase. At the time of the survey data collection, the Japanese PLM project was in the Realization Phase and the US PLM project was in the Blueprint Phase.

Having analyzed and summarized demographic results, I turned to the analysis of RQ1: PLM vision of success.

RQ1: PLM vision of success results.

RQ1: How does vision of success for global PLM IS vary by culture? The DMS Global steering committee created the PLM vision of success, and then communicated the vision to the DMS Global project team. Consequently, the project team's understanding of the vision of success was influenced by the steering committee's communication. In view of this, I used the vision of success themes derived from the stage one steering committee in-depth interviews (i.e. Table 4) as the codebook for the analysis of the vision of success statements given by project team stage two survey participants. The survey included both national culture (Japanese and US) and professional culture (engineering and IT). I will present the results for national culture first, and the results for professional culture second.

Survey vision of success results for national culture.

Of the 38 themes for vision of success identified during the stage one steering committee in-depth interviews (Table 4), 15 (39.47%) were not identified by either Japanese or US survey participants, eight (21.05%) were identified by both Japanese and US survey participants, three (7.89%) were identified by only Japanese survey participants, and 12 (31.58%) were identified by only US survey participants. In addition to the 38 vision of success steering committee themes, the stage two project team survey participants identified the following four new themes for vision of success:

1. Improve Quality. One US participant stated, "Improve quality by controlling drawings in a more formal and automated manner" (SU, ID- 8630715, q. 3.1).
2. Minimize Software Modifications. One US participant commented, "My vision would be maximum utilization with minimum modification to the software. History has shown very little return on investment when systems are modified and adapted to fit preexisting Elliott workflows" (SU, ID- 8726867, q. 3.1).
3. Search Capability. One Japanese participant noted, "In addition, a merit is born that information sharing and new drawings and reports can be promptly made by identifying the information useful for the new products by searching out of the past information" (SU, ID- 8537838, q. 3.1). Similarly, one US participant observed, "The PLM system would provide searching capabilities that would be better than we have today" (SU, ID- 8541915, q. 3.1).
4. Visibility. One US participant remarked, "A standard business process and PLM tool will improve design, product management, and visibility across the organization" (SU, ID- 8460373, q. 3.1).

Survey vision of success results for professional culture.

Of the 38 themes for vision of success identified during the stage one steering committee in-depth interviews (Table 4), 15 (39.47%) were not identified by engineering or IT survey participants, 13 (34.21%) were identified by engineering and IT survey participants, five (13.16%) were identified by only engineering survey participants, and five (13.16%) were identified by only IT survey participants. In addition to the 38 vision of success steering committee themes, the stage two project team survey participants identified the following four new themes for vision of success. These are the same four themes noted in the national culture results above updated to note the professional culture source (IT or engineering) of the new theme:

1. Improve Quality. One participant (IT) included this category in their vision of success statement.
2. Minimize Software Modifications. One participant (engineering) included this category in their vision of success statement.
3. Search Capability. One participant (IT) included this category in their vision of success statement.
4. Visibility. Two participants (2 IT) included this category in their vision of success statement.

Having presented the vision of success results for both national and professional culture, the following section summarizes the findings and considers anticipated and unanticipated results.

RQ1: PLM vision of success results summary.

RQ1: How does vision of success for global PLM IS vary by culture? The survey protocol defined vision of success as, "general statements about what the PLM system will do for DMS Global when implemented." Vision of success is long-term, or strategic in nature. The DMS Global steering committee was comprised of senior leaders. Conversely, the DMS Global project team who completed the survey was comprised of mid-level managers and individual contributors. Given these demographics, my expectation was the steering committee would have a strategic focus and the project team would have a tactical focus. To a large degree this expectation was met. For example, the steering committee in-depth interviews resulted in 38 themes for vision of success and the project team survey resulted in 19 themes for vision of success. The steering committee had double the number of themes. The unanticipated result was the four new categories for vision of success identified by the project team above and beyond the 38 categories already identified by the steering committee.

Five of the 24 participants (20.83%) declined to answer survey question 3.1 regarding vision of success. The national culture mix of the five participants who did not provide a response was four Japanese (80%) and one US (20%). This was predicted by Hofstede's et al. (2010) high uncertainty avoidance score for Japan in Table 1. In other words, I expected Japanese participants to be unwilling to answer a question for which they had high uncertainty.

The professional culture mix of the participants who did not answer survey question 3.1 regarding vision of success was five engineers (100.00%) and zero IT (0.00%). While not predicted by Hofstede et al. (2010), this matched my professional experience with engineers; that is they were precise individuals unwilling to provide ambiguous responses.

RQ2: PLM goals results.

RQ2: How do goals for global PLM IS vary by culture? As with RQ1, I used the goal themes from the stage one steering committee in-depth interviews (i.e. Table 5) as the codebook for the analysis of the goal statements given by project team stage two survey participants. The survey included both national culture (Japanese and US) and professional culture (engineering and IT). I will present the results for national culture first, and the results for professional culture second.

Survey goals results for national culture.

Of the 36 goal themes identified during the stage one steering committee in-depth interviews (Table 5), 12 (33.33%) were not identified by either Japanese or US survey participants, seven (19.44%) were identified by both Japanese and US survey participants, six (16.67%) were identified by only Japanese survey participants, and 11 (30.56%) were identified only by US survey participants. In addition to the 36 goal steering committee themes, the stage two project team survey participants identified the following ten new goal categories:

1. Adaptable PLM Foundation. One participant (US) argued the PLM information system must be easy to tailor (SU, ID-8454050, q. 4.1).
2. Customer Satisfaction. One participant (US) observed the PLM information system should provide customer satisfaction (SU, ID-8454050, q. 4.1).
3. Full Product Lifecycle. One participant (Japanese) asserted the PLM information system must support the product through its full lifecycle including "… design, development, test, [and] aftermarket service" (SU, ID-8613682, q. 4.1).
4. Global Information Sharing. Four participants (two Japanese and two US) included this category in their response. A Japanese participant declared, "…information can

be shared among the worldwide DMS Global subsidiaries such as in America and Europe" (SU, ID-8538529, q. 4.1). Similarly, a US participant wrote, "DMS Global produces a PLM solution that can be used across all BU's and locations" (SU, ID-8630715, q. 4.1).

5. Meet SDLC [Systems Development Lifecycle] Stage Gate Approvals. One participant (US) included this category in their goal statement (SU, ID-8613682, q. 4.1).
6. Retire Legacy PLM Systems. One participant (US) contended the PLM information system must retire the legacy PLM system (SU, ID-8630715, q. 4.1).
7. Robust PLM Functionality. One participant (US) argued the PLM information system must offer improved functionality (SU, ID-8544279, q. 4.1).
8. Single Source of Product Data. Six survey participants (2 Japanese and 4 US) included this goal category in their response. A Japanese participant commented, "Information sharing among the foreign countries with a center operation in Japan and the United States" (SU, ID- 8538023, q. 4.1). A US participant observed, "Minimize the amount of locations an employee has to look for Product/Project related information. We currently have data all over the place (network file shares, Lotus Notes databases, Eigner, file folders, etc.)" (SU, ID- 8544279, q. 4.1).
9. Support Legacy AutoCAD. One participant (Japanese) contended the PLM system needed to, "Support legacy AutoCAD data and provide transition from AutoCAD to ProE if desired" (SU, ID-8613682, q. 4.1).
10. User Satisfaction. One participant (US) maintained the PLM information system should be "user friendly" (SU, ID-8454050, q. 4.1).

Survey goals results for professional culture.

Of the 36 goal themes identified during the stage one steering committee in-depth interviews (Table 5), 12 (33.33%) were not identified by engineering or IT survey participants, nine (25.00%) were identified by engineering and IT survey participants, eight (22.22%) were identified by only engineering survey participants, and 7 (19.44%) were identified by only IT survey participants. In addition to the 36 goal themes identified during the stage one steering committee in-depth interviews, the stage two project team survey participants identified the following ten new goal categories. These are the same ten themes noted in the national culture results above updated to note the professional culture source (IT or engineering) of the new theme:

1. Adaptable PLM Foundation. One participant (engineering) included this category in their goal statement.
2. Customer Satisfaction. One participant (engineering) included this category in their goal statement.
3. Full Product Lifecycle. One participant (engineering) included this category in their goal statement.
4. Global Information Sharing. Four participants (2 engineering, 2 IT) included this category in their goal statement.
5. Meet SDLC [Systems Development Lifecycle] Stage Gate Approvals. One participant (IT) included this category in their goal statement.
6. Retire Legacy PLM Systems. One participant (IT) included this category in their goal statement.

7. Robust PLM Functionality. One participant (IT) included this category in their goal statement.
8. Single Source of Product Data. Six participants (4 engineering, 2 IT) included this category in their goal statement.
9. Support Legacy AutoCAD. One participant (engineering) included this category in their goal statement.
10. User Satisfaction. One participant (engineering) included this category in their goal statement.

RQ2: PLM goals results summary.

RQ2: How do goals for global PLM IS vary by culture? The survey protocol (Appendix F) defined goals as, "specific targets to be met in a period of time to realize the PLM project vision of success." Goals are short-term, or tactical in nature. Accordingly, my expectation was for the survey responses from the project team to be tactical in nature. This expectation was not met. The survey responses identified ten goal categories that the stage one steering committee in-depth interview responses did not. Of these ten additional goals, eight (80.00%) were strategic in nature and two (20.00%) were tactical in nature (i.e. Meet SDLC Stage Gate Approvals and Retire Legacy PLM Systems). This was an unanticipated result.

Nine of 24 participants (37.50%) declined to answer survey question 4.1 regarding goals. The national culture mix of the nine participants who did not provide a response was three Japanese (33.33%) and six US (66.67%). This was an unanticipated result based on Hofstede's et al. (2010) high uncertainty avoidance score for Japan in Table 9. In other words, I expected Japanese participants to be less willing to respond than US participants; however, the data suggests the opposite.

RQ3: PLM CSFs results.

RQ3: What are the CSFs for global PLM IS implementation? The survey protocol (Appendix F) presented the participants with the 20 PLM CSFs derived from the stage one in-depth interview analysis, and then requested they rate CSF importance on a 1 to 7 Likert scale for each of the five project phases picture in Figure *11*.

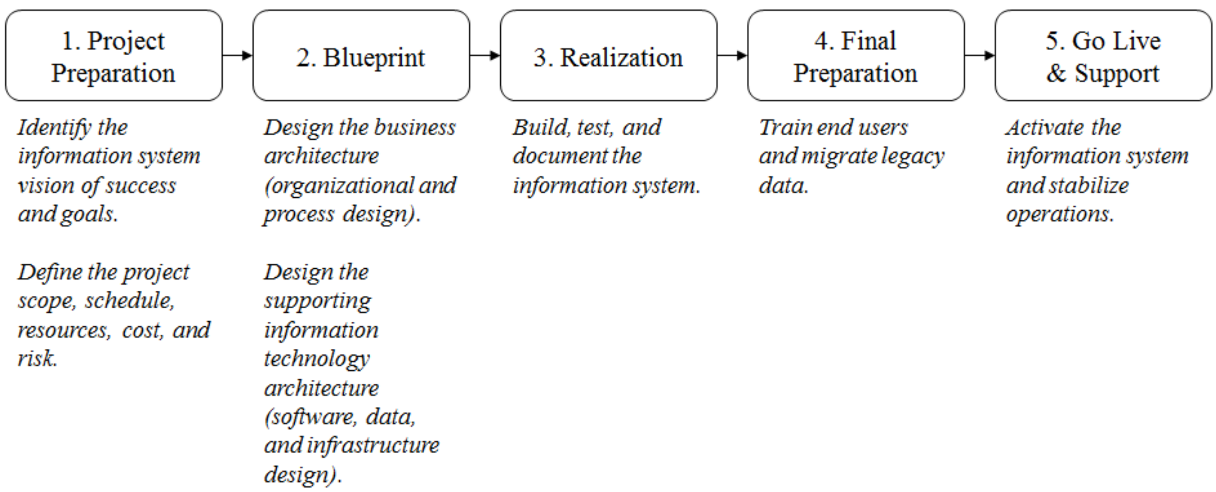

Figure 11. *Survey – Project Phases with Key Outcomes*

The primary focus of the survey was on rating the importance of the existing 20 PLM CSFs by project phase rather than on developing new PLM CSFs. Regardless, after the rating of the PLM CSFs importance for a project phase, the respondent was given the opportunity to add new PLM CSFs they felt were missing for the project phase.

RQ3: did not include culture as a factor. Accordingly, the results for RQ3: are presented in aggregate, rather than being stratified by national and professional culture. Only the top five ranked CSFs were considered during this analysis. The motivation for limiting the number of

CSFs to five was Rockart's (1979) recommendation to focus on a limited number of areas (p. 85). The results for RQ3: are organized in three sections as follows:

1. Aggregate Culture – CSFs – Top Five Listed by Project Phase.
2. Aggregate Culture – CSFs – Top Five Recurrence by Project Phase.
3. Aggregate Culture – CSFs – Added by Survey Participants

Aggregate culture – CSFs – top five listed by project phase.

Table 9 lists the aggregate culture PLM CSF mean importance for the top five ranked PLM CSFs by project phase. Table 37 of Appendix M contains the aggregate culture PLM CSF mean importance for all 20 PLM CSFs for each project phase. The columns of Table 9 are defined as follows:

1. R: the rank of the CSF.
2. PLM CSF: the PLM CSF with a prefix of "PX-" to indicate the project phase.
3. N: the number of respondents.
4. M: the mean importance rating of the CSF.
5. SD: the standard deviation of the mean importance ratings.
6. Min: the minimum rating on the 1 to 7 Likert scale.
7. Max: the maximum rating on the 1 to 7 Likert scale.

Table 9 was sorted by Project Phase, Rank, and CSF.

Table 9. Survey – Aggregate Culture – CSFs Top 5 by Project Phase

R	PLM CSF	N	M	SD	Min	Max
	P1 Project Preparation Phase					
1	P1-18 TopMgmtSupport	20	6.00	0.973	4	7
2	P1-02 BPRCommonProcesses	20	5.90	0.968	4	7
3	P1-01 BusinessCase	20	5.80	0.951	4	7
3	P1-08 GlobalIntegratedSys	20	5.80	1.056	4	7
5	P1-04 ConsultSysIntegrator	20	5.65	1.268	3	7
	P2 Blueprint Phase					
1	P2-02 BPRCommonProcesses	16	6.00	0.894	4	7
2	P2-06 CustSatisfaction	16	5.56	1.153	3	7
3	P2-03 ChangeMgmt	16	5.50	1.095	3	7
4	P2-04 ConsultSysIntegrator	16	5.44	1.459	1	7
4	P2-18 TopMgmtSupport	16	5.44	1.590	1	7
	P3 Realization Phase					
1	P3-17 Testing	19	5.79	1.437	2	7
2	P3-13 ProjMgmt	19	5.53	0.905	4	7
3	P3-19 Training	19	5.47	1.577	2	7
4	P3-15 RiskMgmtQA	19	5.42	1.121	4	7
5	P3-06 CustSatisfaction	19	5.37	1.212	3	7
5	P3-07 DataConversion	19	5.37	1.422	2	7
5	P3-16 TimeSchedule	19	5.37	1.535	1	7
	P4 Final Preparation Phase					
1	P4-13 ProjMgmt	19	5.84	0.834	4	7
2	P4-19 Training	19	5.79	1.084	3	7
3	P4-07 DataConversion	19	5.68	1.108	4	7
4	P4-15 RiskMgmtQA	19	5.47	1.020	4	7
4	P4-16 TimeSchedule	19	5.47	1.679	1	7
4	P4-17 Testing	19	5.47	1.504	2	7
	P5 Go Live & Support Phase					
1	P5-19 Training	19	5.84	1.119	3	7
2	P5-13 ProjMgmt	19	5.53	1.219	2	7
3	P5-20 UserSatisfaction	19	5.47	1.504	1	7
4	P5-07 DataConversion	19	5.37	1.257	3	7
5	P5-17 Testing	19	5.26	1.759	1	7

Having considered the top five ranked PLM CSFs individually by project phase, I focused on their recurrence by project phase.

Aggregate culture – CSFs – top five recurrence by project phase.

Table 10 shows recurrence of the PLM CSFs from Table 9 across the five project phases. The columns of Table 10 were defined as:

1. PLM CSF: The PLM.
2. P1: Project Preparation Phase.
3. P2: Blueprint Phase.
4. P3: Realization Phase.
5. P4: Final Preparation Phase.
6. P5: Go Live & Support Phase.
7. Count: the number of time the CSFs recurs.

The rows of Table 10 were arranged so the recurrence of PLM CSFs flowed from top to bottom by PLM CSF rank; and from left to right by project phase. An entry of “R = 1” at the intersection of a PLM CSF row and project phase indicates the PLM CSF had rank one for the project phase. Similarly, an entry of “R = 4” at the intersection of a PLM CSF row and project phase indicates the PLM CSF had rank four for the project phase.

Table 10. Survey – Aggregate Culture – CSFs Top 5 Recurrence by Phase

PLM CSF	P1	P2	P3	P4	P5	Count
01 BusinessCase	R = 3					1
08 GlobalIntegratedSys	R = 3					1
18 TopMgmtSupport	R = 1	R = 4				2
02 BPRCommonProcesses	R = 2	R = 1				2
04 ConsultSysIntegrator	R = 5	R = 4				2
03 ChangeMgmt		R = 3				1
06 CustSatisfaction		R = 2	R = 5			2
15 RiskMgmtQA			R = 4	R = 4		2
16 TimeSchedule			R = 5	R = 4		2
17 Testing			R = 1	R = 4	R = 5	3
13 ProjMgmt			R = 2	R = 1	R = 2	3
19 Training			R = 3	R = 2	R = 1	3
07 DataConversion			R = 5	R = 3	R = 4	3
20 UserSatisfaction					R = 3	1
Count	5	5	7	6	5	28

When accounting for recurrence, the 28 top five ranked PLM CSFs for all project phases consolidated to 14 unique PLM CSFs in Table 10. Four of 14 PLM CSFs (28.57%) did not recur. Six of 14 PLM CSFs (42.86%) returned in two project phases. Four of 14 PLM CSFs (28.57%) persisted for three project phases. All recurrence of PLM CSFs was continuous; i.e. there were no instance where a CSF recurred in project phases that did not directly follow one another.

Having considered the top five ranked PLM CSFs recurrence by project phase, I focused new CSFs added by survey respondents.

Aggregate culture – CSFs – survey participant additions.

The primary focus of the analysis was rating the importance of the existing 20 PLM CSFs by project phase rather than on developing new PLM CSFs. Regardless, following the rating of PLM CSF importance for each project phase, the respondent was given the opportunity to add new PLM CSFs they felt were missing for the project phase. Table 11 includes additional PLM CSFs recommended by project phase and my response to the recommendation.

Table 11. Survey – Aggregate Culture – Additional CSFs Recommended in Survey

Project Phase	Additional PLM CSF Recommended	Response to Recommendation
P1 Project Prep.	Establishing a common vision - the business case provides some of that, but having key process influencers have a common vision of the end result is very important (SU, ID-8535710, q. 5.1.2).	This is encompassed by CSF 01 Business Case, CSF 09 Goals and Objectives (Scope), and CSF 18 Top Management Support.
	The objective(s) and process should be sufficiently discussed and established at the management level (SU, ID-8537838, q. 5.1.2).	This is encompassed by CSF 09 Goals and Objectives (Scope).
	Before officially starting the project, a time period is needed to sufficiently assess and determine the capability of the consulting firm (SU, ID-8537838, q. 5.1.2).	This is encompassed by CSF 04 Consultant (System Integrator).
	Rather than a manual issued by IT, a user needs to prepare his/her own work manual and have understanding (SU, ID-8537838, q. 5.1.2).	This is encompassed by CSF 19 Training.

Project Phase	Additional PLM CSF Recommended	Response to Recommendation
P2 Blueprint	At the planning stage, establishing the objective(s) and process should be sufficiently discussed (SU, ID-8537838, q. 5.2.2).	This is encompassed by CSF 09 Goals and Objectives (Scope).
	The objective(s) and process should be sufficiently discussed and established at the management level (SU, ID-8537838, q. 5.2.2).	This is encompassed by CSF 18 Top Management Support.
	Before officially starting the project, a time period is needed to sufficiently assess and determine the capability of the consulting firm (SU, ID-8537838, q. 5.2.2).	This is encompassed by CSF 04 Consultant (System Integrator).
	The project team must be 100% dedicated to completing the project, no other workload should be on their plate (SU, ID-8470134, q. 5.2.2).	This is encompassed by CSF 14 Project Team (Resources).
	Rather than a manual issued by IT, a user needs to prepare his/her own work manual and have understanding (SU, ID-8537838, q. 5.2.2).	This is encompassed by CSF 19 Training.
	Ease of use, complexity. (SU, ID-8518650, q. 5.2.2.).	This is encompassed by CSF 20 User Satisfaction.
P3 Realization	No additional PLM CSFs were recommended.	No response was required.
P4 Final Prep.	No additional PLM CSFs were recommended.	No response was required.
P5 Go Live & Sup.	No additional PLM CSFs were recommended.	No response was required.

Table 11 identified four additional PLM CSFs recommended for P1 Project Preparation, and six additional PLM CSFs recommended for P2 blueprint. There were no additional PLM CSFs recommended for P3 Realization, P4 Final Preparation, or P5 Go Live & Support. All of the additional PLM CSFs recommended were encompassed by the existing 20 PLM CSFs. Regardless, the recommended additions provide insights into the following concerns of the project team:

- A clearly defined and communicated vision of success.
- A clearly defined and communicated set of objectives or goals.
- Selection of consulting firm (systems integrator) that is technically component, understands the DMS Global business needs, and willing to work collaboratively.
- Selection of a project team that is not only technically competent, but also able to dedicate the required time to the PLM project.
- Effective user training that includes documentation prepared by and for end users rather than IT.
- Implementation of a PLM information system that meets needs in a simple, user friendly manner.

RQ3: PLM CSFs results summary.

RQ3: What are the CSFs for global PLM IS implementation? When studying ERP IS implementation, Somers and Nelson (2001) identified 22 ERP CSFs, and then ranked ERP CSF importance by project phase (p. 7). Table 12 compares the top five ranked PLM CSFs by project phase with the corresponding top five ranked ERP CSFs. The data was sorted by PLM rank, and then by ERP rank.

Table 12. Survey – Aggregate Culture – CSFs Top 5 PLM Compared to ERP

PLM		ERP	
R	CSF	CSF	R
	P1 Project Preparation (Initiation) Phase		
1	P1-18 TopMgmtSupport	17 Top Management Support	3
2	P1-02 BPRCommonProcesses	01 Architecture Choices	1
3	P1-01 BusinessCase	-	
3	P1-08 GlobalIntegratedSys	-	
5	P1-04 ConsultSysIntegrator	13 Partnership with Vendor	3
	-	05 Clear Goals & Objectives	2
	-	03 Careful Selection of Package	4
	P2 Blueprint (Adoption) Phase		
1	P2-02 BPRCommonProcesses	-	
2	P2-06 CustSatisfaction	-	
3	P2-03 ChangeMgmt	-	
4	P2-04 ConsultSysIntegrator	13 Partnership with Vendor	3
4	P2-18 TopMgmtSupport	17 Top Management Support	1
		19 Use of Steering Committee	4
	-	16 Project team competence	2
	-	07 Dedicated resources	4
	P3 Realization (Adaption) Phase		
1	P3-17 Testing	-	
2	P3-13 ProjMgmt	-	
3	P3-19 Training	-	
4	P3-15 RiskMgmtQA	-	
5	P3-06 CustSatisfaction	-	
5	P3-07 DataConversion	-	
5	P3-16 TimeSchedule	-	
	-	09 Interdepartmental communication	1
	-	10 Interdepartmental cooperation	2
	-	16 Project team competence	2
	-	07 Dedicated resources	3
	-	20 Use of vendors' tools	3

PLM		ERP	
R	CSF	CSF	R
	P4 Final Preparation (Acceptance) Phase		
1	P4-13 ProjMgmt	-	
2	P4-19 Training	08 Education on new business proc.	4
3	P4-07 DataConversion	-	
4	P4-15 RiskMgmtQA	-	
4	P4-16 TimeSchedule	-	
4	P4-17 Testing	-	
	-	09 Interdepartmental communication	1
	-	10 Interdepartmental cooperation	2
	-	17 Top management support	3
	-	16 Project team competence	4
	P5 Go Live & Support (Routinization) Phase		
1	P5-19 Training	21 User training on software	4
2	P5-13 ProjMgmt	-	
3	P5-20 UserSatisfaction	-	
4	P5-07 DataConversion	-	
5	P5-17 Testing	-	
	-	09 Interdepartmental communication	1
	-	17 Top management support	2
	-	10 Interdepartmental cooperation	3
	-	22 Vendor support	4

A review of the data in Table 12 found three CSFs in common for phase 1 project preparation; two CSFs in common in phase 2 blueprint, no CSFs in common for phase 3 realization, one CSF in common for phase 4 final preparation, and one CSF in common for phase 5 go live & support. The ERP CSF of top management support had the most recurrences with four of five project phases. Accordingly, I expected top management support to be the most common PLM CSF. This expectation was not met as top management support appeared in only two of five project phases.

Having analyzed and summarized the results for RQ3: PLM CSFs, I turned to the analysis of RQ4: PLM CSFs by Culture.

RQ4: PLM CSF importance by culture results.

RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation? The survey protocol (Appendix F) presented the participants with the 20 PLM CSFs derived from the stage one in-depth interview analysis, and then requested they rate PLM CSF importance on a 1 to 7 Likert scale for each of the five project phases. RQ4: examined the difference in importance placed on the PLM CSFs by national culture (Japanese and US) and professional culture (engineering and IT).

Rockart (1979) recommended analysts focus on a limited number of CSFs (p. 85). Accordingly, the quantitative analysis of the survey data involved both identifying the top five ranked PLM CSFs by culture and the generation and analysis variance (ANOVA) for mean importance by culture. Therefore the tables and figures which follow include only the top five ranked PLM CSFs by culture and/or PLM CSFs with statistically significant differences as determined by the ANOVA.

National culture – CSFs – top five & significant ANOVA by project phase.

Table 13 through Table 17 contain the top five ranked PLM CSFs by national culture and PLM CSFs with statistically significant differences (Sig. <= 0.050) as determined by the ANOVA for national culture by project phase. Figure 40 through Figure 44 of Appendix M are graphical representations of the data in Table 13 through Table 17. The columns of the tables are defined as follows:

1. PLM CSF: the CSF with rank one to five or a statistically significant ANOVA. PLM CSFs were given a prefix of "PX-" to indicate the project phase.

2. R: the rank of the CSF
3. N: the number of respondents
4. M: the mean importance rating of the CSF
5. SD: the standard deviation of the mean importance ratings
6. Sig: the significance value from the ANOVA

Shaded cells indicate either rank one to five or a statistically significance difference based on the ANOVA. The table was sorted by PLM CSF.

Areas of potential conflict worthy of additional management attention are indicated by two patterns of data. First are rows where either the Japan rank is shaded or the US rank is shaded, but not both. This pattern indicates the CSF is ranked in the top five for one culture, but not the other. Second are rows where the significance factor is shaded which indicates the difference in means between cultures could not have occurred merely by chance alone.

Table 13. Survey – National Culture – CSFs Top 5 & ANOVA P1 Project Prep.

	JP				US				
PLM CSF P1 Project Prep.	R	N	M	SD	R	N	M	SD	Sig.
P1-01 BusinessCase	3	8	5.75	0.89	2	16	5.94	1.00	.658
P1-02 BPRCommonProcesses	5	8	5.50	1.07	6	16	5.75	1.53	.684
P1-03 ChangeMgmt	9	8	5.00	1.31	3	16	5.88	0.72	.044
P1-04 ConsultSysIntegrator	1	8	5.88	1.13	10	16	5.50	1.21	.472
P1-08 GlobalIntegratedSys	1	8	5.88	0.99	11	16	5.50	1.55	.541
P1-09 GoalsObjectives	4	8	5.50	0.93	9	16	5.63	1.02	.774
P1-12 PLMSysEvalSelect	6	8	5.25	1.16	5	15	5.80	1.01	.252
P1-14 ProjTeamResources	8	8	5.25	0.89	4	16	5.88	0.96	.137
P1-18 TopMgmtSupport	9	8	5.00	0.76	1	16	6.38	0.81	.001

Table 13 had nine PLM CSFs. DMS Global should focus their management attention on the CSFs that are rank 1 for one culture but not the other because these CSFs represent disagreement on the most important CSFs. DMS Global may also want to concentrate on P1-03 Change Management because it has a statistically significant difference based on the ANOVA and it is a top five ranked CSF.

Table 14. Survey – National Culture – CSFs Top 5 & ANOVA P2 Blueprint

	JP				US				
PLM CSF P2 Blueprint	R	N	M	SD	R	N	M	SD	Sig.
P2-01 BusinessCase	2	8	5.63	0.92	19	15	4.93	2.05	.379
P2-02 BPRCommonProcesses	1	8	5.88	0.99	1	16	5.81	0.98	.885
P2-03 ChangeMgmt	6	8	5.25	1.04	3	15	5.60	1.06	.454
P2-04 ConsultSysIntegrator	2	8	5.63	0.92	11	16	5.25	1.57	.541
P2-06 CustSatisfaction	10	8	5.13	1.55	2	16	5.63	0.72	.287
P2-07 DataConversion	4	8	5.25	0.89	7	15	5.40	1.72	.821
P2-11 PastExpLessonsLearn	14	8	4.88	0.99	5	16	5.50	0.97	.153
P2-14 ProjTeamResources	4	8	5.25	0.89	6	15	5.47	1.41	.698
P2-18 TopMgmtSupport	10	8	5.13	1.25	4	16	5.56	1.50	.486

Table 14 had nine PLM CSFs. Japan and the US are aligned on the top ranked CSFs. Given this alignment, I recommend DMS Global focus management attention on CSF P2-01 Business Case because it has rank 2 for Japan, rank 19 for the US, yielding an absolute rank difference of 17 (which is the largest in Table 14).

Table 15. Survey – National Culture – CSFs Top 5 & ANOVA P3 Realization

	JP				US				
PLM CSF P3 Realization	R	N	M	SD	R	N	M	SD	Sig.
P3-04 ConsultSysIntegrator	2	7	5.57	1.27	13	14	5.14	1.66	.556
P3-05 BudgetCost	5	7	5.29	1.11	18	16	4.88	1.59	.543
P3-06 CustSatisfaction	16	8	4.75	1.39	4	16	5.63	1.02	.094
P3-09 GoalsObjectives	3	8	5.38	0.74	14	14	5.14	1.41	.671
P3-10 ImplementStrategy	4	6	5.33	1.03	16	15	5.07	1.39	.677
P3-13 ProjMgmt	6	8	5.25	1.04	3	16	5.69	0.70	.233
P3-15 RiskMgmtQA	15	8	4.88	0.99	4	16	5.63	1.02	.102
P3-16 TimeSchedule	1	8	5.63	0.74	10	16	5.38	1.63	.686
P3-17 Testing	19	8	4.50	1.41	1	16	6.44	0.73	.000
P3-19 Training	16	8	4.75	1.39	2	16	5.94	1.34	.055
P3-20 UserSatisfaction	19	8	4.50	1.41	6	15	5.60	0.83	.027

Table 15 had 11 PLM CSFs. DMS Global should focus their management attention on the CSFs that are rank 1 for one culture but not the other because these CSFs represent disagreement on the most important CSFs. Of particular importance is P3-17 Testing which has rank 19 for Japan, rank 1 for the US, yielding an absolute rank difference of 18, and has a statistically significant based on the ANOVA. Even though P3-20 User Satisfaction has a statistically significant difference based on the ANOVA, I would not recommend directing management attention on this CSF because it is not ranked in the top five.

Table 16. Survey – National Culture – CSFs Top 5 & ANOVA P4 Final Prep.

	JP				US				
PLM CSF P4 Final Prep.	R	N	M	SD	R	N	M	SD	Sig.
P4-04 ConsultSysIntegrator	4	7	5.57	1.13	18	14	4.57	1.91	.220
P4-05 BudgetCost	4	7	5.57	0.98	16	16	4.69	1.70	.216
P4-07 DataConversion	11	8	5.25	1.04	2	15	6.13	0.99	.058
P4-13 ProjMgmt	3	8	5.63	0.74	3	15	5.93	0.80	.377
P4-15 RiskMgmtQA	14	8	5.13	0.83	4	16	5.69	0.95	.169
P4-16 TimeSchedule	1	8	5.75	0.89	9	15	5.40	1.80	.614
P4-17 Testing	2	7	5.71	0.95	5	16	5.56	1.59	.818
P4-19 Training	6	8	5.38	0.74	1	16	6.25	1.06	.050

Table 16 had eight CSFs. DMS Global should focus their management attention on the CSFs that are rank 1 for one culture but not the other culture because these CSFs represent disagreement on the most important CSFs. Further, P4-19 Training is rank 1 and has a statistically significant difference based on the ANOVA. Finally, DMS Global may wish to concentrate on P4-04 Consultant / Systems Integrator because it has rank 4 for Japan, rank 18 for the US, yielding an absolute rank difference of 12 (which is the largest in Table 16).

Table 17. Survey – National Culture – CSFs Top 5 & ANOVA P5 Go Live & Sup.

	JP				US				
PLM CSF P5 Go Live & Sup.	R	N	M	SD	R	N	M	SD	Sig.
P5-05 BudgetCost	5	7	5.43	1.13	17	14	4.29	2.09	.196
P5-07 DataConversion	20	7	4.71	1.25	2	12	5.75	1.14	.082
P5-08 GlobalIntegratedSys	16	7	4.86	1.21	5	12	5.33	1.78	.540
P5-13 ProjMgmt	6	7	5.43	0.98	3	16	5.50	1.41	.905
P5-16 TimeSchedule	2	7	5.57	0.79	8	14	5.14	2.03	.601
P5-17 Testing	2	7	5.57	0.98	10	13	5.08	2.02	.552
P5-19 Training	1	8	5.88	0.99	1	15	5.87	1.13	.986
P5-20 UserSatisfaction	2	7	5.57	1.13	4	15	5.47	1.55	.875

Table 17 had eight PLM CSFs. Japan and the US are aligned on the top ranked CSF. Given this alignment, I recommend DMS Global focus management attention on P5-07 Data Conversion because it has rank 20 for Japan, rank 2 for the US, yielding an absolute rank difference of 18 (which is the largest in Table 17).

Having considered the difference by national culture and project phase, the following section consolidates the data across project phases.

National culture – CSFs – top five & significant ANOVA consolidation.

The top five ranked PLM CSFs with large absolute difference by national culture represent areas of potential conflict. Table 18 identifies the PLM CSFs with the largest absolute differences in rank by project phase. The data in Table 18 was sorted by project phase and PLM CSF.

Table 18. Survey – National Culture – CSFs Top 5 Rank Consolidated

	JP				US				
PLM CSF	R	N	M	SD	R	N	M	SD	Sig.
P1-08 GlobalIntegratedSys	1	8	5.88	0.99	11	16	5.50	1.55	.541
P2-01 BusinessCase	2	8	5.63	0.92	19	15	4.93	2.05	.379
P3-17 Testing	19	8	4.50	1.41	1	16	6.44	0.73	.000
P4-04 ConsultSysIntegrator	4	7	5.57	1.13	18	14	4.57	1.91	.220
P5-07 DataConversion	20	7	4.71	1.25	2	12	5.75	1.14	.082

A review of the data in Table 18 indicates Japan has a desire for a globally integrated PLM system supported by a strong business case and strong third party consultant/systems integrator. The US, however, is focused on testing and data conversion/migration. While the diversities in rank point to distinctions based on national culture, to assert an actual difference based on national culture I turned to the ANOVA.

ANOVA calculates a significance value, which if less than or equal to 0.050 implies the difference in means between groups could not have occurred merely by chance alone (Nardi, 2006, pp. 168–187). Table 19 contains PLM CSFs with statistically significant differences for national culture. The data Table 19 was sorted by project phase, and then PLM CSF.

Table 19. Survey – National Culture – CSFs ANOVA Consolidated

	JP				US				
PLM CSF	R	N	M	SD	R	N	M	SD	Sig.
P1-03 ChangeMgmt	9	8	5.00	1.31	3	16	5.88	0.72	0.044
P1-18 TopMgmtSupport	9	8	5.00	0.76	1	16	6.38	0.81	0.001
P3-17 Testing	19	8	4.50	1.41	1	16	6.44	0.73	0.000
P3-20 UserSatisfaction	19	8	4.50	1.41	6	15	5.6	0.83	0.027
P4-19 Training	6	8	5.38	0.74	1	16	6.25	1.06	0.050

There were five PLM CSFs with statistically significant differences based on national culture. Phase 1 Project Preparation had two (40.00%), Phase 3 Realization had two (40.00%), and Phase 4 Final Preparation had the remaining one (20.00%). Phase 2 Blueprint and Phase 5 Go Live & Support had no CSFs with statistically significant differences. The following three PLM CSFs with statistically significant differences were rank one; representing the potential for conflict on the most important CSF for either the Japanese or the US:

1. P1-18 Top Management Support
2. P3-17 Testing
3. P4-19 Training

There were no PLM CSFs with statistically significant difference that recurred across project phase.

A review of Table 19 found the US rated importance higher than the Japanese for all five CSFs (100.00%). This implies the US may have a bias to rate the importance of PLM CSFs higher than the Japanese. Conversely, the standard deviation was relatively balanced between cultures as the US had higher standard deviations for two PLM CSFs (40.00%), and the Japanese had higher standard deviations for the remaining three (60.00%).

Having considered differences based on national culture, I focused on differences driven by professional culture.

Professional culture – CSFs – top five & significant ANOVA by project phase.

Table 20 through Table 24 contain the top five ranked PLM CSFs by professional culture and PLM CSFs with statistically significant differences (Sig. <= 0.050) as determined by the ANOVA for professional culture. Figure 45 through Figure 49 of Appendix M are graphical representations of the data in Table 20 through Table 24. The columns of the tables are defined as follows:

1. PLM CSF: the CSF with rank one to five or a statistically significant ANOVA. CSFs were given a prefix of "PX-" to indicate the project phase.
2. R: the rank of the CSF
3. N: the number of respondents
4. M: the mean importance rating of the CSF
5. SD: the standard deviation of the mean importance ratings
6. Sig: the significance value from the ANOVA

Shaded cells indicate rank one to five or a statistically significant difference based on the ANOVA. The table was sorted by PLM CSF.

Areas of potential conflict worthy of additional management attention are indicated by two patterns of data. First are rows where either the Japan rank is shaded or the US rank is shaded, but not both. This pattern indicates the CSF is ranked in the top five for one culture, but not the other. Second are rows where the significance factor is shaded which indicates the difference in means between cultures could not have occurred merely by chance alone.

Table 20. Survey – Professional Culture – CSFs Top 5 & ANOVA P1 Project Prep.

	ENG				IT				
CSF – P1 Project Preparation	R	N	M	SD	R	N	M	SD	Sig.
P1-01 BusinessCase	2	15	5.80	1.08	4	9	6.00	0.71	.627
P1-02 BPRCommonProcesses	1	15	5.93	0.96	15	9	5.22	1.86	.227
P1-04 ConsultSysIntegrator	10	15	5.47	1.36	5	9	5.89	0.78	.405
P1-07 DataConversion	5	15	5.67	1.45	17	9	4.67	1.50	.120
P1-09 GoalsObjectives	14	15	5.27	0.88	3	9	6.11	0.93	.037
P1-11 PastExpLessonsLearn	3	15	5.67	1.11	18	9	4.56	1.24	.033
P1-14 ProjTeamResources	12	15	5.27	0.96	1	9	6.33	0.50	.006
P1-18 TopMgmtSupport	3	15	5.67	1.11	2	9	6.33	0.71	.123

Table 20 displays eight CSFs. DMS Global should focus their management attention on the CSFs that are rank 1 for one culture but not the other because these CSFs represent disagreement on the most important CSFs. It should be noted that P1-02 Business Process Reengineering / Common Processes has rank 1 for engineering, rank 15 for IT, yielding an absolute rank difference of 14 (the largest in Table 20). DMS Global should also concentrate on P1-09 Goals Objectives and P1-11 Past Experience / Lessons Learned because they have statistically significant differences based on the ANOVA and are ranked in the top five.

Table 21. Survey – Professional Culture – CSFs Top 5 & ANOVA P2 Blueprint

	ENG				IT				
CSF – P2 Blueprint	R	N	M	SD	R	N	M	SD	Sig.
P2-02 BPRCommonProcesses	1	15	6.00	1.00	1	9	5.56	0.88	.283
P2-03 ChangeMgmt	2	15	5.73	0.96	8	8	5.00	1.07	.108
P2-04 ConsultSysIntegrator	3	15	5.67	0.98	11	9	4.89	1.83	.186
P2-06 CustSatisfaction	4	15	5.60	1.12	4	9	5.22	0.97	.411
P2-11 PastExpLessonsLearn	10	15	5.40	1.12	5	9	5.11	0.78	.505
P2-13 ProjMgmt	16	15	5.13	0.92	3	9	5.22	0.83	.814
P2-14 ProjTeamResources	4	15	5.60	0.91	8	8	5.00	1.69	.277
P2-15 RiskMgmtQA	13	15	5.27	1.03	5	9	5.11	0.78	.701
P2-18 TopMgmtSupport	9	15	5.47	1.13	2	9	5.33	1.87	.828
P2-20 UserSatisfaction	20	15	5.00	1.07	5	9	5.11	1.05	.807

Table 21 had ten CSFs. Engineering and IT are aligned on the top ranked CSF. Given this alignment, I recommend DMS Global focus management attention on the rank two CSFs. DMS Global may also want to concentrate on P2-20 User Satisfaction which has rank 20 for engineering, rank 5 for IT, yielding an absolute rank difference of 15 (the largest in Table 21).

Table 22. Survey – Professional Culture – CSFs Top 5 & ANOVA P3 Realization

	ENG				IT				
CSF – P3 Realization	R	N	M	SD	R	N	M	SD	Sig.
P3-02 BPRCommonProcesses	17	15	5.20	1.21	5	8	5.13	0.83	.877
P3-04 ConsultSysIntegrator	4	15	5.60	1.18	16	6	4.50	2.07	.138
P3-07 DataConversion	4	15	5.60	1.12	8	8	5.00	1.60	.304
P3-11 PastExpLessonsLearn	2	15	5.67	1.23	18	8	4.00	1.85	.017
P3-12 PLMSysEvalSelect	17	15	5.20	1.47	20	6	3.50	2.07	.047
P3-13 ProjMgmt	11	15	5.40	0.91	2	9	5.78	0.67	.292
P3-14 ProjTeamResources	3	14	5.64	1.08	12	8	4.88	1.89	.235
P3-15 RiskMgmtQA	13	15	5.33	1.23	4	9	5.44	0.73	.809
P3-16 TimeSchedule	1	15	5.73	0.96	8	9	5.00	1.87	.216
P3-17 Testing	4	15	5.60	1.50	1	9	6.11	1.05	.381
P3-19 Training	4	15	5.60	1.45	3	9	5.44	1.51	.805

Table 22 had 11 CSFs. DMS Global should focus first on P3-16 Time Schedule which has rank 1 for engineering, rank 8 for IT, yielding an absolute rank difference of 7. DMS Global should also concentrate on P3-11 Past Experience / Lessons Learned because it has a statistically significant difference based on the ANOVA; and this CSF has the largest absolute rank difference in Table 22.

Table 23. Survey – Professional Culture – CSFs Top 5 & ANOVA P4 Final Prep.

	ENG				IT				
CSF – P4 Final Preparation	R	N	M	SD	R	N	M	SD	Sig.
P4-06 CustSatisfaction	3	15	5.80	1.26	10	8	4.63	1.30	.048
P4-07 DataConversion	3	15	5.80	1.15	3	8	5.88	0.99	.877
P4-09 GoalsObjectives	13	15	5.33	0.90	18	6	3.83	2.04	.028
P4-10 ImplementStrategy	9	15	5.53	0.74	17	7	4.00	1.91	.012
P4-11 PastExpLessonsLearn	10	15	5.53	1.06	16	8	4.13	1.81	.027
P4-12 PLMSysEvalSelect	19	14	5.07	1.38	19	6	3.17	2.56	.043
P4-13 ProjMgmt	6	14	5.79	0.89	2	9	5.89	0.60	.764
P4-15 RiskMgmtQA	10	15	5.53	0.83	4	9	5.44	1.13	.827
P4-16 TimeSchedule	1	15	6.00	1.00	10	8	4.63	2.00	.037
P4-17 Testing	3	15	5.80	0.94	5	8	5.25	2.05	.384
P4-19 Training	2	15	5.93	0.96	1	9	6.00	1.22	.883

Table 23 had 11 CSFs. DMS Global should focus management attention first on P4-16 Time Schedule which has rank 1 for engineering, rank 10 for IT, yielding an absolute rank difference of 9 (the largest in Table 23); and this CSF has a statistically significant difference based on the ANOVA. Next, DMS Global should concentrate on P4-06 Customer Satisfaction which also has a statistically significant difference based on the ANOVA. While there are four other CSFs with statistically significant differences based on the ANOVA, I would not recommend directing management attention on these CSFs because they are not ranked in the top five.

Table 24. Survey – Professional Culture – CSFs Top 5 & ANOVA P5 Go Live & Sup.

	ENG				IT				
CSF – P5 Go Live & Support	R	N	M	SD	R	N	M	SD	Sig.
P5-04 ConsultSysIntegrator	7	14	5.43	1.16	20	6	3.00	2.10	.003
P5-07 DataConversion	12	13	5.31	1.18	3	6	5.50	1.52	.766
P5-08 GlobalIntegratedSys	14	13	5.23	1.01	4	6	5.00	2.53	.776
P5-09 GoalsObjectives	16	14	5.07	0.83	16	6	3.50	2.35	.036
P5-10 ImplementStrategy)	7	14	5.43	1.02	15	8	3.63	2.20	.015
P5-11 PastExpLessonsLearn	3	15	5.80	1.08	17	6	3.33	2.42	.004
P5-13 ProjMgmt	9	15	5.40	1.12	2	8	5.63	1.60	.697
P5-14 ProjTeamResources	11	14	5.36	1.01	5	8	4.88	2.47	.523
P5-16 TimeSchedule	4	14	5.79	0.97	11	7	4.29	2.43	.055
P5-17 Testing	4	14	5.79	0.97	13	6	4.00	2.45	.028
P5-19 Training	1	15	5.93	0.96	1	8	5.75	1.28	.702
P5-20 UserSatisfaction	1	15	5.93	0.96	7	7	4.57	1.81	.030

Table 24 had 12 CSFs. DMS Global should focus first on CSF P5-20 User Satisfaction because it has rank 1 for engineering, rank 7 for IT, yielding an absolute rank difference of 5; and this CSF has a statistically significant difference based on the ANOVA. Next, DMS Global should concentrate on P5-11 Past Experience / Lessons Learned because it has rank 3 for engineering, rank 17 for IT, yielding an absolute rank difference of 14 (the largest in Table 24); and this CSF has a statistically significant difference based on the ANOVA. After this, DMS Global should emphasize P5-17 Testing because this CSF also has a statistically significant difference based on the ANOVA. While there are three other CSFs with statistically significant differences based on the ANOVA, I would not recommend directing management attention on these CSFs because they are not ranked in the top five.

Having considered the difference by professional culture and project phase, the following section consolidates the data across project phases.

Professional culture – CSFs – top five & significant ANOVA consolidation.

This section considers differences by professional culture across project phases along two dimensions. First, I will first identify the top five ranked PLM CSFs with the largest difference by professional culture. Second I will summarize PLM CSF with statistically significant differences based on the ANOVA by professional culture.

The top five ranked CSFs with large absolute difference by professional culture represent areas of potential conflict. Table 25 summarized the CSFs with the largest absolute differences in rank by project phase. The data in Table 25 was sorted by project phase and CSF.

Table 25. Survey – Professional Culture – CSFs Top 5 Rank Consolidated

	ENG				IT				
PLM CSF†	R	N	M	SD	R	N	M	SD	Sig.
P1-02 BPRCommonProcesses	1	15	5.93	0.96	15	9	5.22	1.86	0.227
P2-20 UserSatisfaction	20	15	5.00	1.07	5	9	5.11	1.05	0.807
P3-11 PastExpLessonsLearn	2	15	5.67	1.23	18	8	4.00	1.85	0.017
P4-16 TimeSchedule	1	15	6.00	1.00	10	8	4.63	2.00	0.037
P5-11 PastExpLessonsLearn	3	15	5.80	1.08	17	6	3.33	2.42	0.004

A review of the data in Table 25 indicates engineering has a desire for common processes, learning from past experience, and a valid time schedule. IT, however, is focused on user satisfaction.

While the diversities in rank point to distinctions based on professional culture, to assert an actual difference based on professional culture I turned to the ANOVA. Table 26 contains PLM CSFs with statistically significant differences for national culture based on the ANOVA by professional culture. The data represented in Table 26 was sorted by project phase, and then PLM CSF.

Table 26. Survey – Professional Culture – CSFs ANOVA Consolidated

	ENG				IT				
PLM CSF	R	N	M	SD	R	N	M	SD	Sig.
P1-09 GoalsObjectives	14	15	5.27	0.88	3	9	6.11	0.93	0.037
P1-11 PastExpLessonsLearn	3	15	5.67	1.11	18	9	4.56	1.24	0.033
P1-14 ProjTeamResources	12	15	5.27	0.96	1	9	6.33	0.50	0.006
P3-11 PastExpLessonsLearn	2	15	5.67	1.23	18	8	4.00	1.85	0.017
P3-12 PLMSysEvalSelect	17	15	5.20	1.47	20	6	3.50	2.07	0.047
P4-06 CustSatisfaction	3	15	5.80	1.26	10	8	4.63	1.30	0.048
P4-09 GoalsObjectives	13	15	5.33	0.90	18	6	3.83	2.04	0.028
P4-10 ImplementStrategy	9	15	5.53	0.74	17	7	4.00	1.91	0.012
P4-11 PastExpLessonsLearn	10	15	5.53	1.06	16	8	4.13	1.81	0.027
P4-12 PLMSysEvalSelect	19	14	5.07	1.38	19	6	3.17	2.56	0.043
P4-16 TimeSchedule	1	15	6.00	1.00	10	8	4.63	2.00	0.037
P5-04 ConsultSysIntegrator	7	14	5.43	1.16	20	6	3.00	2.10	0.003
P5-09 GoalsObjectives	16	14	5.07	0.83	16	6	3.50	2.35	0.036
P5-10 ImplementStrategy	7	14	5.43	1.02	15	8	3.63	2.20	0.015
P5-11 PastExpLessonsLearn	3	15	5.80	1.08	17	6	3.33	2.42	0.004
P5-17 Testing	4	14	5.79	0.97	13	6	4.00	2.45	0.028
P5-20 UserSatisfaction	1	15	5.93	0.96	7	7	4.57	1.81	0.03

There were 17 PLM CSFs with statistically significant differences based on professional culture. Phase 1 Project Preparation had three (17.65%), Phase 3 Realization had two (11.76%), and Phase 4 Final Preparation had six (35.29%), and Phase 5 Go Live & Support had the remaining six (35.29%). Phase 2 Blueprint had no PLM CSFs with statistically significant differences. Three PLM CSFs with statistically significant differences were rank one representing the potential for conflict on the most important PLM CSF for either engineering or IT:

1. P1-14 Project Team Resources
2. P4-16 Time Schedule
3. P5-20 User Satisfaction

The following four PLM CSFs with statistically significant differences recurred across project phases:

1. 09 Goals & Objectives (Scope): Phase 1, Phase 4, Phase 5
2. 10 Implementation Strategy: Phase 4, Phase 5
3. 11 Past Experience (Lessons Learned): Phase 1, Phase 3, Phase 4, Phase 5
4. PLM System Evaluation & Selection: Phase 3, Phase 4

A review of Table 26 found engineering rated importance higher than IT for 15 of 17 PLM CSFs (88.24%). This implies engineering may have a bias to rate the importance of PLM CSFs higher than IT. Conversely, IT had a larger standard deviation for 16 of 17 PLM CSFs (94.12%). This indicates a wider diversity of opinion regarding importance among IT associates.

Having considered differences in PLM CSFs importance based on national culture and professional culture, the following section summaries the cultural analysis.

RQ4: PLM CSF importance by culture results summary.

RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation? Two dimensions of culture were considered; national (Japanese and US) and professional (engineering and IT). For each dimension of culture, I examined PLM CSFs ranked in the top five and PLM CSFs with statistically significant difference based on the analysis of variance (ANOVA).

For the top five ranked PLM CSFs, I identified the PLM CSFs with the largest difference in rank based on culture for each project phase. These PLM CSFs represented areas for potential conflict due to the large variance in rank. While these diversities in rank pointed to distinctions based on culture, to assert an actual difference based on culture I utilized the ANOVA results.

The ANOVA found 22 PLM CSFs with statistically significant differences; five (22.73) based on national culture and 17 (67.27%) based on professional culture. There were no PLM CSFs with statistically significant differences for phase 2 blueprint. There were no PLM CSFs that had a statistically significant difference for both national and professional culture.

RQ4: PLM CSFs by Culture was the final research question addressed by the stage two survey data collection and analysis. Hence the following section summarizes the stage two survey data collection and analysis results

Stage two: survey results summary.

Stage two data collection involved a survey of the DMS Global PLM project team and focused on RQ1, RQ2, RQ3, and RQ4. From the population of 41, 24 completed surveys were obtained yielding a response rate of 57.14%. The national culture mix was 33.30% Japanese and 66.70% US. The professional culture mix was 62.50% engineer and 37.50% IT. The majority of respondents (83.30%) had 16 years or more of work experience. Despite the relatively long work experience, the majority of the respondents (79.17%) had no global IS implementation experience.

RQ1: How does vision of success for global PLM IS vary by culture? My expectation was the steering committee would have a strategic focus and the project team would have a tactical focus. Accordingly, it would be difficult for project team members to articulate a vision of success. To a large degree this expectation was met. Regardless, analysis of the data led to the identification of the following four new success themes:

1. Improve Quality.
2. Minimize Software Modifications.
3. Search Capability.
4. Visibility.

Japanese participants demonstrated higher uncertainty avoidance than US participants. The national culture mix of the five participants who elected to skip the vision of success question was four Japanese (80%) and one US (20%). Similarly, engineers were more risk-adverse than IT associates. The professional culture mix of the participants who declined to answer the vision of success question was five engineers (100%) and zero IT (0%).

RQ2: How do goals for global PLM IS vary by culture? An unanticipated result was the identification of the following ten additional goal themes:

1. Adaptable PLM Foundation.
2. Customer Satisfaction.
3. Full Product Lifecycle.
4. Global Information Sharing.
5. Meet SDLC [Systems Development Lifecycle] Stage Gate Approvals.
6. Retire Legacy PLM Systems.
7. Robust PLM Functionality.
8. Single Source of Product Data.
9. Support Legacy AutoCAD.

10. User Satisfaction.

Of these ten additional goals, eight (80%) were strategic in nature and two (20%) were tactical in nature (i.e. Meet SDLC Stage Gate Approvals and Retire Legacy PLM Systems). This too was an unanticipated result.

RQ3: What are the CSFs for global PLM IS implementation? The primary objective of the survey was to rate (on a 1 to 7 Likert scale) the relative importance of the 20 PLM CSFs identified during the stage one in-depth interviews for each of the five project phases. Regardless, the survey respondents were given an opportunity to add new PLM CSFs. While ten new PLM CSFs were suggested, all ten were encompassed by the existing 20 PLM CSFs. As noted previously the PLM CSFs were a subset of the ERP CSFs. The ERP CSF of top management support had the most recurrences with four out of five project phases. Accordingly, I expected top management support to be the most common PLM CSF. This expectation was not met as top management support appeared in only two out of five project phases.

RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation? There were 22 PLM CSFs with statistically significant difference based on the ANOVA by culture; 5 driven by national culture and 17 driven by professional culture. The following three PLM CSFs had both a statistically significant difference based on the ANOVA by national culture, and were ranked number one in importance for a project phase:

1. P1-18 Top Management Support
2. P3-17 Testing
3. P4-19 Training

These CSFs represent the potential for conflict on the most important PLM CSF for either Japan or the US and warrant additional management care. Similarly, the following three PLM CSFs had both a statistically significant difference based on the ANOVA by professional culture, and were ranked number one in importance for a project phase:

1. P1-14 Project Team Resources
2. P4-16 Time Schedule
3. P5-20 User Satisfaction

The results indicate that culture, both national and professional, influences the relative importance of PLM CSFs by project phase. Both the ranking of CSF importance by project phase and the ANOVA by culture can be used to identify areas of potential conflict worthy of additional management attention.

Stage Three: Focus Group Results

The focus group gathered data to answer the following research questions (Appendix G, Appendix K):

RQ3: What are the CSFs for global PLM IS implementation?

RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation?

RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs?

The objectives of the focus groups were to collect the data necessary to answer the research questions. To that end, the focus group protocol defined in the Methods chapter and Appendix G was followed.

As noted in the methodology chapter, I used the axial coding method from Strauss and Corbin's (1998) work on grounded theory to analyze the data collected. I created Figure 12 to portray the relationship between the three components of their axial coding paradigm (Strauss & Corbin, 1998, p. 128).

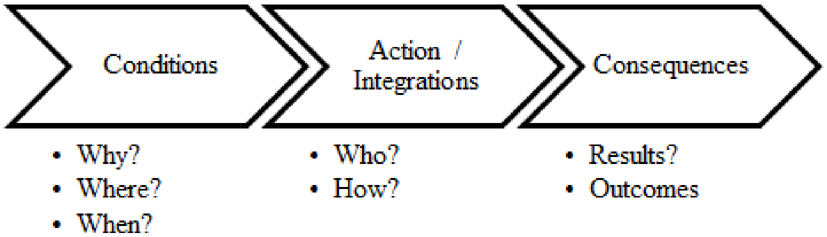

Figure 12. Focus Group – Axial Coding Paradigm

The flow was from conditions to actions / interactions to consequences. Accordingly, I reviewed the focus group transcript for answers to the questions of: why, where, when, who, how, with what results, and with what outcome. After answering these questions, I assembled the answers according to the paradigm which provided the foundation for the preliminary theoretical framework integrating global PLM IS implementation, culture, and CSFs.

Participant demographics results.

The survey population was the all-male (100%) eight member DMS Global steering committee. Two identical focus groups were planned to minimize social pressure to participate because it was less obvious if a steering committee member chose not to attend either focus group meeting. Regardless, all eight steering committee members elected to attend the second focus group meeting. On the day of the meeting, however, only five of the eight (62.5%) steering committee members attended. As a result, the national culture participant mix (Japanese 60%, US 40%) was almost the opposite of the population mix (Japanese 37%, US 63%). Conversely, the professional culture mix of the participants (engineering 80%, IT 20%) was a rough approximation of the population mix (engineering 62%, IT 25%).

In addition to comparing the focus group participants to the population, I also analyzed the volume of participant contribution. Specifically, I reviewed the focus group transcript and counted the following data:

1. Concurrence Instances: the number of instances where a participant agreed with the data presented in the focus group protocol and provided no additional information.
2. Concurrence Lines: for each instance of concurrence, I counted the number of lines of text the participant response required in the transcript. Partial lines were rounded up the nearest whole number. For example, a responds of three and one-quarter lines was counted as four.
3. New Information Instances: the number of instances where a participant added new information in response to the data presented in the focus group protocol, rather than simply concurring.
4. New Information Lines: for each instance of new information, I counted the number of lines of text the participant response required in the transcript. Partial lines were rounded up the nearest whole number. For example, a responds of three and one-quarter lines was counted as four.

The results of the participant volume analysis for national and professional culture are provided in Table 27 and Table 28 respectively.

Table 27. Focus Group – National Culture – Participant Volume Analysis

	Japan				US			
	Concur		New Info.		Concur		New Info.	
Focus Group Sec.	Inst.[†]	Lines	Inst.	Lines	Inst.	Lines	Inst.	Lines
1. Introduction & Review of Research Design	2	2	-	-	2	2	-	-
2. CSF Importance Ratings by Phase	5	5	2	4	3	7	13	40
3. Top 5 Ranked CSFs by Phase	2	2	-	-	-	-	4	14
4. CSF ANOVA Aggregate Culture Summary	1	1	-	-	-	-	3	7
5. CSF ANOVA National Culture Detail Data	1	1	1	3	-	-	5	8
6. CSF ANOVA Professional Culture Detail	-	-	-	-	1	1	5	15
7. Open Forum	3	6	-	-	-	-	5	31
8. Conclusion	1	1	-	-	1	1	-	-
Total	15	18	3	7	7	11	35	115

Note. [†]Inst. = Instance.

A review of the data in Table 27 found the US participants provided a large portion of the content even though 60% of the participants were Japanese as follows:

1. Concurrence Instances: The majority (86%) of the instances of concurrence with the data in the focus group protocol came from the Japanese:

- 22 Instances
- 15 Japanese Instances (68%)
- 07 US Instances (32%)

2. Concurrence Lines: From the instances of concurrence, the majority (62%) of the lines of text in the transcript came from the Japanese:
    - 29 Lines
    - 18 Japanese Lines (62%)
    - 11 US Lines (38%)
3. New Information Instances: The majority (92%) of the instances of new information in response to the data in the focus group protocol came from the US:
    - 38 Instances
    - 3 Japanese Instances (8%)
    - 35 US Instances (92%)
4. New Information Lines: From the instances of new information, the majority (94%) of the lines of text in the transcript came from the US:
    - 122 Lines
    - 007 Japanese Lines (6%)
    - 115 US Lines (94%)

In summary, the Japanese associates were reluctant to disagree with the information I presented in the focus group protocol. The US associates were more willing to present different interpretations of the data. Further, as noted above, the majority of new information (upward of 90%) came from US associates.

Table 28. Focus Group – Professional Culture – Participant Volume Analysis

	Engineer				IT			
	Concur		New Info.		Concur		New Info.	
Focus Group Sec.	Inst.	Lines	Inst.	Lines	Inst.	Lines	Inst.	Lines
1. Introduction and Review of Research Design	4	4	-	-	-	-	-	-
2. CSF Importance Ratings by Phase	8	12	15	44	-	-	-	-
3. Top 5 Ranked CSFs by Phase	2	2	4	14	-	-	-	-
4. CSF ANOVA Aggregate Culture Summary	1	1	3	7	-	-	-	-
5. CSF ANOVA National Culture Detail Data	1	1	6	11	-	-	-	-
6. CSF ANOVA Professional Culture Detail	1	1	5	15	-	-	-	-
7. Open Forum	2	4	5	31	1	2	-	-
8. Conclusion	2	2	-	-	-	-	-	-
Total	21	27	38	122	1	2	-	-

Note. †Inst. = Instance

A review of the data in Table 28 found the engineering participants provided a large portion of the content. This was anticipated given 80% of the participants were engineers as follows:

1. Concurrence Instances: The majority (95%) of the instances of concurrence with the data in the focus group protocol came from engineering:

- 22 Instances
- 21 engineering Instances (95%)
- 01 IT Instances (5%)

2. Concurrence Lines: From the instances of concurrence, the majority (93%) of the lines of text in the transcript came from engineering:
    - 29 Lines
    - 27 engineering Lines (93%)
    - 02 IT Lines (7%)
3. New Information Instances: The majority (100%) of the instances of new information in response to the data in the focus group protocol came from engineering:
    - 38 Instances
    - 38 engineering Instances (100%)
    - 00 IT Instances (0%)
4. New Information Lines: From the instances of new information, all (100%) of the lines of text in the transcript came from the engineering:
    - 122 Lines
    - 122 engineering Lines (100%)
    - 000 IT Lines (0%)

In summary, the one IT participant present at the focus group contributed only two lines of comments, and these two lines of content concurred with the information I presented in the focus group. Accordingly, the bulk of the content came from the engineering participants.

Participant demographic results summary.

A review of the demographic data led to the following observations. The participation rate was 62.50% (five or eight steering committee members).

The national culture mix of the participants was 60% Japanese to 40% US. Conversely, the majority of the new information (92% of the instance and 94% of the lines of text in the transcript) came from US participants. Further, all of the Japanese input came from one individual, until section 8 of the focus group protocol, during which I asked each individual one-by-one for input. These results were anticipated given the Japanese tendency toward uncertainty avoidance and a desire for collectivism as shown in Table 1.

The professional culture mix of the participants was 80% engineering and 20% IT. As expected, the majority of the new information (100% of the instances and lines of text) came from engineering.

RQ3: PLM CSFs results.

RQ3: What are the CSFs for global PLM IS implementation? Section 2 (discussion of the CSF importance rating by project phase) and section 3 (discussion of the top five ranked CSFs by project phase) of the focus group protocol (Appendix G) gathered data related to RQ3. I will present the result for section 2 first, followed by the result for section 3.

In section 2, the participants were shown five tables, one per project phase, of PLM CSFs sorted in order of descending mean importance. For each table, the participants were asked if they agreed with the top five ranked PLM CSFs and if they had further observations regarding the data. In addition to these two questions, I asked the participants a probing question regarding the data that I had prepared in advance of the meeting.

My first analysis was to review the focus group transcript to identify changes to PLM CSF importance recommended by the participants. The participants focused primarily on the top five ranked CSFs and recommended the following changes:

- P1 Project Preparation Phase
    - Add CSF 09 Goals & Objectives (Scope). Add CSF 14 Project Team (Resources).

      "We are okay with, more or less, agree with question 5. But goal and objectives and project team resources that should be higher on the list I think" (FG, ID-36, p. 10).
- P2 Blueprint Phase
    - Remove CSF 06 Customer Satisfaction. Add CSF 11 Past Experience (Lessons Learned).

      "I was a little bit confused with the customer satisfaction being ranked so highly in the blueprint phase. I wasn't quite sure what the origin of that [was]; I think that I would have placed that lower and I might have placed lessons learned higher, for instance" (FG, ID-22, p.13).

      "I noticed that as well. Customer satisfaction was 14 in the previous list and it jumped very high to the top 5" (FG, ID-17, p. 14)
    - Add CSF 20 User Satisfaction.

      "You would maybe expect user satisfaction to be up at that level because you are designing it for the users" (FG, ID-17, p. 14).

- P3 Realization Phase
  - Add CSF 20 User Satisfaction. Remove CSF 06 Customer Satisfaction.

    "…I was surprised that user satisfaction wasn't higher than customer satisfaction at that point in the project" (FG, ID-22, p. 16).
- P4 Final Preparation Phase
  - Lack of concurrence on CSF 13 Project Management.

    "It is interesting that project management is so high. At this point, I think all - that point of work has been completed" (FG, ID-17, p. 18).

    "Although, I interpreted that as almost an expediter type role. The prodding and the keeping people on schedule and so I actually thought that was kind of reasonable because it shows differences of perspectives" (FG, ID-22, p. 19).
- P5 Go Live & Support
  - Remove CSF 07 Data Conversion.

    "I thought that the data conversion ranked number 4, I think this is something we should have done maybe earlier so that data conversion should not be as high on the list as it is. In other words it should be lower on the list" (FG, ID-36, p. 20).
  - Add CSF 18 Top Management Support.

    "Truly, I thought it [i.e. top management support] would be important to get the project launched and then the middle I thought was basically core team and others, and then I actually thought it should be of importance for the roll out" (FG, ID-18, p. 28).

- Add new CSF XX Go Live User Support.

  "One area, or subject that I thought might just be missing from the choices or the weighing though is user support. Considering it is the go live support or go live phase. To me the question of user support might be valid" (FG, ID-22, p. 21).

Having completed the analysis of recommended changes to the top five ranked PLM CSFs, I turned my focus to axial coding (Figure 12). I reviewed the transcript for answers to the question of: why, where, when (conditions), who, how (actions / interactions), results, and outcomes (consequences). The answers to these questions led me to the following five relational statements, or hypothesis, that link conditions, actions / interactions, and outcomes (Strauss & Corbin, 1998, p. 135). The hypotheses are presented in the order in which they occurred in the focus group transcript. Some of the hypothesis recurred in later sections of the focus group transcript. To avoid confusion, I chose to give each hypothesis a unique number (denoted by a prefix of H-XX) and name. Following each hypothesis, I provided supporting participant quotations from the focus group transcript:

- H-01 Traumatic past experience identifies PLM CSFs with low quality outcomes.

  "I don't know that like just looking at the three items that received a 1 for min [ranking] realizing that these 3 are events that happen at the end of the project typically, but also thinking to some of my experiences here at DMS Global these are also ones that we might seem to be weaker at" (FG, ID-17, p. 10).

- H-02 Early intervention improves PLM CSF outcomes.

  "So maybe giving more consideration to that initially would yield better results. And maybe it is the case then, of course if you run into some issue later, it is easy to say well we should have done training on that or we should have done testing on that. Maybe it is just like hindsight is 20/20 type of thing" (FG, ID-17, p. 10).

- H-03 Top management communication overrides culture.

  I asked probing question P-01, "What do you think contributed to the high importance ranking and low standard deviation of Business Process Reengineering (Common Processes)?" One participant responded, "From my vantage point, I think it is a combination of upper management direction of a general message of desired integration which this fits into that envelope and also an individual driven desire recognizing that often we are interacting with our counterpart in [Japan] and so it's driven by the individual experience to have that commonality driven home" (FG, ID-22, p. 11).

- H-04 There exist phase-specific PLM CSFs where importance is dependent on the project phase.

  "I also think following up [ID-36's] comment about project team resources, I note that it hung down, while it was number 8 on the first page it is now number 7. That may be jumping ahead a little bit but it seems like it generally hangs in that second 5 tier, never cracking the top 5. I think that resources need to be a major consideration at some point" (FG, ID-14, p. 14). "How about back to [ID-17's] comment, I was surprised that user satisfaction wasn't higher than customer satisfaction at that point in the project …. I was also surprised that the large standard deviation for testing, considering that this was a named phase of testing for the program" (FG, ID-22, pp. 16-17). "It is interesting that project management is so high. At this point, I think all - that point of work has been completed" (FG, ID-17, p. 18). "I thought that the data conversion ranked number 4, I think this is something we should have done maybe earlier so that data conversion should not be as high on the list as it is" (FG, ID-36, p. 20).

- H-05 There exist cross-phase PLM CSFs where importance is not dependent on the project phase.

  "I was also surprised that the large standard deviation for testing, considering that this was a named phase of testing for the program. I was surprised that it wasn't a more universal top rank" (FG, ID-22, p. 17). "It is interesting that project management is so high. At this point, I think all - that point of work has been completed" (FG, ID-17, p. 18). "Although, I interpreted that as almost an expediter type role. The prodding and the keeping people on schedule and so I actually thought that was kind of reasonable because it shows differences of perspectives" (FG, ID-22, p. 19).

In section 3, the participants were shown tables which combined the top five ranked PLM CSFs for each project phase. The participants were simply asked what observation they had regarding the data. In addition, I asked the participants the probing question regarding the data that I had prepared in advance of the meeting.

My first analysis was to review the focus group transcript to identify changes to PLM CSF importance recommended by the participants. Below are their recommended changes by project phase:

- P1 Project Preparation Phase
    - There were no recommended changes for this phase.

- P2 Blueprint Phase
    - Add CSF 13 Project Management. "You can see the project management [in phase] 04 but it should have come up in [phase] 02" (FG, ID-36, p. 23).
    - Remove CSF 03 Change Management. "I was kinda maybe a little bit surprised; about the change management was ranked high. It is in the blueprint phase not in any of the later phases when to me you would actually have good changes. Testing [phase 03] and/or final preparation [phase 04] are areas where I think you would start discover possible areas you would want to have change but change management wasn't a factor, a top 5 factor in those areas" (FG, ID-22, p. 24)
- P3 Realization Phase
    - There were no recommended changes for this phase.
- P4 Final Preparation Phase
    - There were no recommended changes for this phase.
- P5 Go Live & Support
    - Remove CSF 17 Testing. "I would also say that in [phase] 05 testing is very important but really at that phase, testing should be complete" (FG, ID-17, p. 23).

Next, I turned my focus to the axial coding (Figure 12) and identification of relational statements, or hypothesis. I found no new hypothesis. However, hypotheses H-02, H-04, and H-05 recurred:

- H-02 Early intervention improves PLM CSF outcomes.

  "I see this as DMS Global's current perception of project management and change management. For me I would think that a stronger project management plan and presence in the beginning would eliminate the need for project management later in the process where it is mostly expediting and those types of things. And that is where your change management … we are good about talking about changes but following through and implementing them is the most difficult part so that would be to [ID-17's] point later in the process" (FG, ID-17, pp. 24-25).

- H-04 There exist phase-specific PLM CSFs where importance is dependent on the project phase.

  "You can see the project management [in phase] 04 but it should have come up in [phase] 02" (FG, ID-36, p. 23). "I would also say that in [phase] 05 testing is very important but really at that phase, testing should be complete" (FG, ID-17, p. 23). "I think the presentation just further supports [ID-17's] observation about testing maybe not being properly phased" (FG, ID-22, p. 28).

- H-05 There exist cross-phase PLM CSFs where importance is not dependent on the project phase.

  "I was kinda maybe a little bit surprised; about the change management was ranked high. It is in the blueprint phase not in any of the later phases when to me you would actually have good changes. Testing [phase 03] and/or final preparations [phase 04] are areas where I think you would start to discover possible areas you would want to have change but change management wasn't a factor, a top 5 factor in those areas" (FG, ID-22, p. 24). "Truly, I thought it [CSF 18 Top Management Support] would be important to get the project launched [phase 01] and then the middle I thought was basically core team and others, and then I actually thought it should be of importance for the roll out [phase 04 and 05]" (FG, ID-17, p. 28).

RQ3: PLM CSFs results summary.

RQ3: What are the CSFs for global PLM IS implementation? RQ3: was addressed by section 2 (discussion of the CSF importance rating by project phase) and section 3 (discussion of the top five ranked CSFs by project phase) of the focus group protocol (Appendix G). My analysis of the data was twofold. First, I documented changes recommended by the focus group to the PLM CSFs importance by project phase resulting from the stage two project team survey data. Second, I identified relational statements, or hypothesis, made by the focus group in response to the PLM CSF data from the project team data. Changes to PLM CSF importance will be presented first. Hypotheses will be presented second.

The focus group concentrated their comments on the top five ranked CSFs by project phase. Table 29 summarized the changes recommend by the stage three steering committee focus group superimposed on the original table of PLM CSFs (i.e. Table 10) resulting from the stage two project team survey. An "S" indicates data that was unchanged from the survey. A bold "FG +" indicates the CSF was added by the focus group. Conversely, a bold "FG – "indicates a CSF was removed by the focus group.

Table 29. Focus Group - Aggregate Culture - CSFs Top 5 Focus Group Changes

CSF	P1	P2	P3	P4	P5	Count
01 BusinessCase	S					1
08 GlobalIntegratedSys	S					1
09 GoalsObjectives	**FG +**					1
14 ProjectTeam	**FG +**					1
02 BPRCommonProcesses	S	S				2
04 ConsultSysIntegrator	S	S				2
18 TopMgmtSupport	S	S			**FG+**	3
11 PastExperience		**FG +**				1
06 CustSatisfaction		**FG -**	**FG -**			0
13 ProjMgmt		**FG +**	S	S	S	4
03 ChangeMgmt		**FG -**	**FG +**	**FG +**		2
15 RiskMgmtQA			S	S		2
16 TimeSchedule			S	S		2
17 Testing			S	S	**FG -**	2
07 DataConversion			S	S	**FG -**	2
19 Training			S	S	S	3
20 UserSatisfaction			**FG +**		S	2
xx GoLiveUserSup					**FG+**	1
Count	7	5	8	7	5	32

Summarizing the data in Table 29, the focus group added nine PLM CSFs and removed five PLM CSFs for a net change of plus four PLM CSFs. Table 29 clearly indicates that PLM CSF importance varies by project phase.

In addition to modifications to the top five PLM CSFs by project phase, the focus group dialog also gave rise to the following five hypotheses:

1. H-01 Traumatic past experience identifies PLM CSFs with low quality outcomes.
2. H-02 Early intervention improves PLM CSF outcomes.
3. H-03 Top management communication overrides culture.
4. H-04 There exist phase-specific PLM CSFs where importance is dependent on the project phase.
5. H-05 There exist cross-phase PLM CSFs where importance is not dependent on the project phase.

RQ4: PLM CSFs by culture results.

RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation? Section 4 (discussion of the analysis of variance aggregate culture summary), section 5 (discussion of the analysis of variance national culture details data), and section 6 (discussion of the analysis of variance national culture details data) of the focus group protocol (Appendix G) gathered data related to RQ4. I presented the results for section 4 first, followed by the results for section 5, and concluded with the results for section 6.

In section 4 of the focus group protocol, the participants were shown the data in Table 30. This table counted the number of PLM CSFs with statistically significant differences from the analysis of variance (ANOVA) of the stage two project team survey data.

Table 30. Focus Group - CSFs ANOVA Summary

Project Lifecycle Phase	National Culture	Professional Culture	Total
01 Project Preparation	2	3	5
02 Blueprint	-	-	-
03 Realization	2	2	4
04 Final Preparation	1	6	7
05 Go Live & Support	-	6	6
Total	5	17	22

Participants were then asked if they would have expected differences to be more pronounced in national or professional culture? One Japanese participant stated he felt the data was appropriate (FG, ID-36, p. 31). One US participant noted, "From my vantage point, I was just a little bit surprised that there was more of a professional cultural difference than a national, but overall, I thought it was tough to reach any conclusions since I didn't know the individual subjects [i.e. CSFs] from that particular table" (FG, ID-22, p. 31).

When the discussion ended, I asked the participants probing question 09 from the focus group protocol (Appendix G); why do you think there were no CSFs with statistically significant differences in the Blueprint Phase? The response was:

> I think that if you go back to the top CSF, being common business practices, that is a strong message passed down from top management and it is also a quality objective, you know it is very prevalent in our culture here. I think people… you know, the message is working (FG, ID-17, p. 33).

This sentiment expressed in this answer supports hypothesis H-03 which claims top management communication can overcome cultural difference that led to variances in PLM CSF importance rating.

In section 5, the participants were shown tables and figures of the five CSFs with statistically significant differences based on national culture from the stage two survey data. I asked the participants if they were surprised by the results. One US participant stated he was not surprised by the results (FG, ID-17, p. 38). The other US participant was surprised by the different perceptions of CSF 17 Testing (FG, ID-22, p. 38). A Japanese participant commented:

> The difference in the testing between the US and Japan I think it is due to the fact that the US had the experience of implementing [a legacy PLM system], and therefore you were able to take advantage of that. So you viewed the importance of, you recognized the importance of, testing more. And as for [Japan], even though we don't have any problems right now, maybe we should have done the testing earlier. (FG, ID-36, p. 39)

This insight supports both hypothesis Traumatic past experience identifies PLM CSFs with low quality outcomes, and hypothesis Early intervention improves PLM CSFs outcomes. Further, this dialog raised a new hypothesis:

- H-06 Past Experience overrides culture.

My final question for section 5 was, which CSFs with statistically significant differences do you feel represent areas of potential conflict worthy of additional management care? While the participants did not identify any PLM CSFs worthy of additional management care, one US participant observed, "I would say no in this case because the largest one of testing is very important to the US but not [Japan] but in this case they are already passed the testing point"

(FG, ID-17, p. 39). This sentiment parallels hypothesis H-04: There exist phase-specific CSFs where importance is dependent on the project phase.

In section 6, the participants were shown tables and figures of the 17 PLM CSFs with statistically significant differences based on professional culture from the stage two survey data. I asked the participants if they were surprised by the results. The first participant to speak was an engineer. He noted:

> I grouped them. I thought that the user satisfaction, testing, past lessons learned and even to a lesser extent the consultation system integrator and the implementation strategy were all reflective of user environment. I'll call them voice of customer concerns. And I, to me I was surprised and I think it's concerning that basically engineers who are the customers are saying these are all important issues and IT is saying they're not. (FG, ID-22, 45)

Another engineer countered, "The engineers are 5.5 across the board - their mean is pretty even for each one; too conservative to say something is not important" (FG, ID-17, p. 46). The first engineer responded by stating, "To me, I still just think it is a critical indicator" (FG, ID-22, p. 46). Later in section 7 (an open forum where each participant was asked to provide individual feedback) an engineer from Japan framed the mean importance rating difference between engineers and IT as, "… differences between users and supplier" (FG, ID-09, p. 48).

The dialog related to significant differences in importance rankings between engineering (users of an IS) and IT (suppliers of an IS) led to three additional hypotheses:

- H-07 Engineering associates have a bias toward rating PLM CSF importance higher than IT associates.
- H-08 Customers (users) of an information system have a bias toward rating PLM CSF importance higher than suppliers of an information system.

- H-09 PLM CSFs with statistically significant differences indicate potential problems worthy of additional management care.

No additional questions were asked during section 6.

RQ4: PLM CSFs by culture results summary.

RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation? RQ4: was addressed by section 4 (discussion of the analysis of variance aggregate culture summary), section 5 (discussion of the analysis of variance national culture details data), and section 6 (discussion of the analysis of variance national culture details data) of the focus group protocol (Appendix G). The participant discussion did not raise any new PLM CSFs, or alter the importance of the 20 PLM CSFs resulting from the stage one in-depth interview data analysis. The focus group did, however, make relational statements that resulted in the identification of the following four additional hypotheses:

1. H-06 Past Experience overrides culture.
2. H-07 Engineering associates have a bias toward rating PLM CSF importance higher than IT associates.
3. H-08 Customers (users) of an information system have a bias toward rating PLM CSF importance higher than suppliers of an information system.
4. H-09 PLM CSFs with statistically significant differences indicate potential problems worthy of additional management care.

RQ5: preliminary theoretical framework results.

RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs? To answer this research question, I leveraged Strauss and Corbin's (1998) work on selective coding (p. 143). They noted the purpose of selective coding was to present findings as an integrated set of concepts rather than a list of themes (Strauss & Corbin, 1998, p. 145). I merged the 20 PLM CSFs and the nine hypotheses generated during the focus group data analysis into a theoretical framework integrating global PLM IS implementations, culture, and CSFs.

Theoretical framework architecture.

To aid the analyst in selective coding, Strauss and Corbin (1998) recommended diagramming as an effective technique (p. 153). They observed:

> Diagramming is helpful because it enables the analyst to gain distance from the data, forcing him or her to work with concepts rather than with details of data. It also demands the analyst think very carefully about the logic of relationships because if the relationships are not clear, then the diagrams come across as muddled and confused. (Strauss & Corbin, 1998, p. 153)

Diagramming not only reduced research bias by interjecting distance from the data, but also helped clarify relationships among the data. Strauss and Corbin (1998) advised against attempting to include every concept, or theme, that emerged during the research (1998, p. 153). Like CSFs, selective coding should focus on the major categories arising from the micro-analysis and axial coding (Strauss & Corbin, 1998, p. 153).

The challenge, therefore, was to integrate the nine axial coding hypotheses into a concise diagram integrating global PLM IS implementations, culture, and CSFs. As the foundation for the theoretical framework diagram I employed Strauss and Corbin (1998) axial coding paradigm (Figure 12). Upon the axial coding foundation, I chose to expand and categorize conditions as causal, intervening, and contextual, defined Strauss and Corbin (1998) as:

1. Causal conditions usually represent sets of events or happenings that influence phenomena. (131)
2. Intervening conditions are those that mitigate or otherwise alter the impact of causal condition on phenomena. (131)
3. Contextual conditions are the specific sets of conditions (patterns of conditions) that intersect dimensionally at this time and place to create the set of circumstances or problems to which persons respond through actions / interactions. (132)

To arrive at the final architecture for the theoretical framework (Figure 13) diagram, I adapted the grounded theory structure utilized by Morrow and Smith (1995) because their model (p. 27) added the three categories of conditions (causal, intervening, and contextual) to Strauss and Corbin's (1990, 1998) axial coding paradigm (Figure 8).

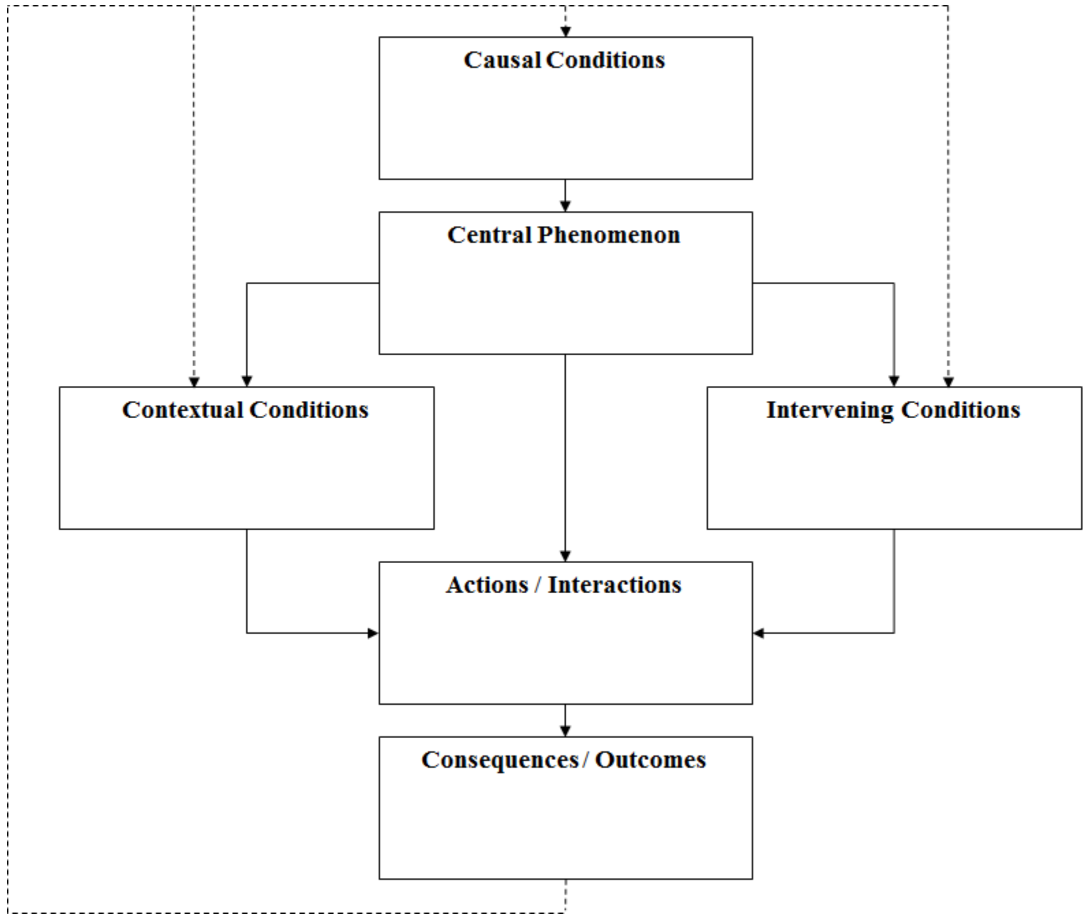

Figure 13. Focus Group – Theoretical Framework Architecture

The theoretical framework architecture begins with causal conditions which give rise to the central phenomenon. The central phenomenon may lead directly to actions / interactions, or alternatively give rise to contextual and intervening conditions that affect actions / interactions. The actions / interactions lead to consequences / outcomes which may, or may not, meet expectations. In either case, the consequences / outcomes may give rise to causal conditional; thus looping back to the top of the theoretical framework.

The next step in theory development was to apply this theoretical framework architecture to the DMS Global PLM IS implementation case. Specifically, I needed to identify causal conditions, the central phenomenon, contextual conditions, intervening conditions, actions / interactions, and consequences / outcomes.

Causal conditions.

I began by identifying causal conditions; those that give rise to, or influence the central phenomenon (Creswell, 2007, p. 64; Strauss & Corbin, 1998, p. 131). The DMS Global identified two root causes: disparate engineering processes and disparate IS (DMS Global, 2010, p. 9). The dissimilar processes and IS created barriers to enterprise growth.

Central phenomenon.

In response to this challenge, DMS Global launched a multi-year project to implement an enterprise-wide commercial off-the-shelf PLM IS with the goal of automating engineering business processes in a manner that improved integration and productivity. The global PLM IS implementation became the central phenomenon of the theoretical framework.

Contextual conditions.

Contextual conditions were defined as narrow in scope, episodic in nature, and bound by time and place (Creswell, 2007, pp. 64–65; Strauss & Corbin, 1998, pp. 131–133). Professional culture was narrower in scope than national culture. Therefore I classified professional culture as a contextual condition. In addition to professional culture, the following three hypotheses represented contextual conditions:

- H-04 There exist phase-specific PLM CSFs where importance is dependent on the project phase.
- H-07 Engineering associates have a bias toward rating PLM CSF importance higher than IT associates.

- H-08 Customers (users) of an information system have a bias toward rating PLM CSF importance higher than suppliers of an information system.

When populating the theoretical framework architecture I decided to merge H-07 with H-08 because both hypotheses addressed the same relationship, but H-08 was broader and easily encompassed H-07.

Intervening conditions.

Having identified hypotheses related to context, I then considered intervening conditions which were defined as broad in scope, constant in nature, and not bound by time and place (Creswell, 2007, pp. 64–65). Intervening conditions also "… mitigate or otherwise alter the impact of causal conditions on the phenomenon" Strauss & Corbin, 1998, p. 131). National culture was broader in scope than professional culture. Therefore, I classified national culture as an intervening condition. The following two hypotheses aligned the criteria for intervening conditions:

- H-03 Top management communication overrides culture.
- H-05 There exist cross-phase PLM CSFs where importance is not dependent on the project phase.

Actions / interactions.

The central phenomenon, contextual conditions, and intervening conditions promote actions / interactions. Actions / interactions were defined as routine or strategic response of groups and individuals to the phenomenon (Strauss & Corbin, 1998, p. 128). PLM CSFs (the limited areas for which satisfactory results ensure success) represent the actions / interactions for the implementation of a global PLM IS. A review of the hypotheses found one that aligned with the criterion for actions / interactions:

- H-02 Early intervention improves PLM CSF outcomes.

This hypothesis is valid only if the root cause of the problem was a lack of time. My experience, however, has proved that improving outcome is rarely as simple as investing more time. Working harder is not as effective as working smarter. To work smarter requires first identifying root causes(s) of the defect, then adjust the process and its input to eliminate, or mitigate, the chance of shortcomings.

Consequences / outcomes.

The final component of the theoretical framework architecture was consequences / outcomes. Consequences were defined as, "… the outcomes of actions/interactions" (Strauss & Corbin, 1998, p. 128). Given the central phenomenon was the implementation of a global PLM IS; the desired outcome would be attainment of the PLM goals and PLM vision of success. An outcome of working toward the implementation of a global PLM IS implementation was past experience. Therefore, I included the following three hypotheses related to past experience as consequences / outcomes:

- H-01 Traumatic past experience identifies PLM CSFs with low quality outcomes
- H-06 Past Experience overrides culture.
- H-09 PLM CSFs with statistically significant differences indicate potential problems worthy of additional management care.

Past experience, both traumatic and non-traumatic, act as causal conditions that loop back to the top of the theoretical framework.

Populated theoretical framework architecture.

Having identified the element required by the theoretical framework architecture, the final step was to populate the theoretical framework architecture. Figure 14 represents the completed preliminary theoretical framework for the implementation of a global PLM IS.

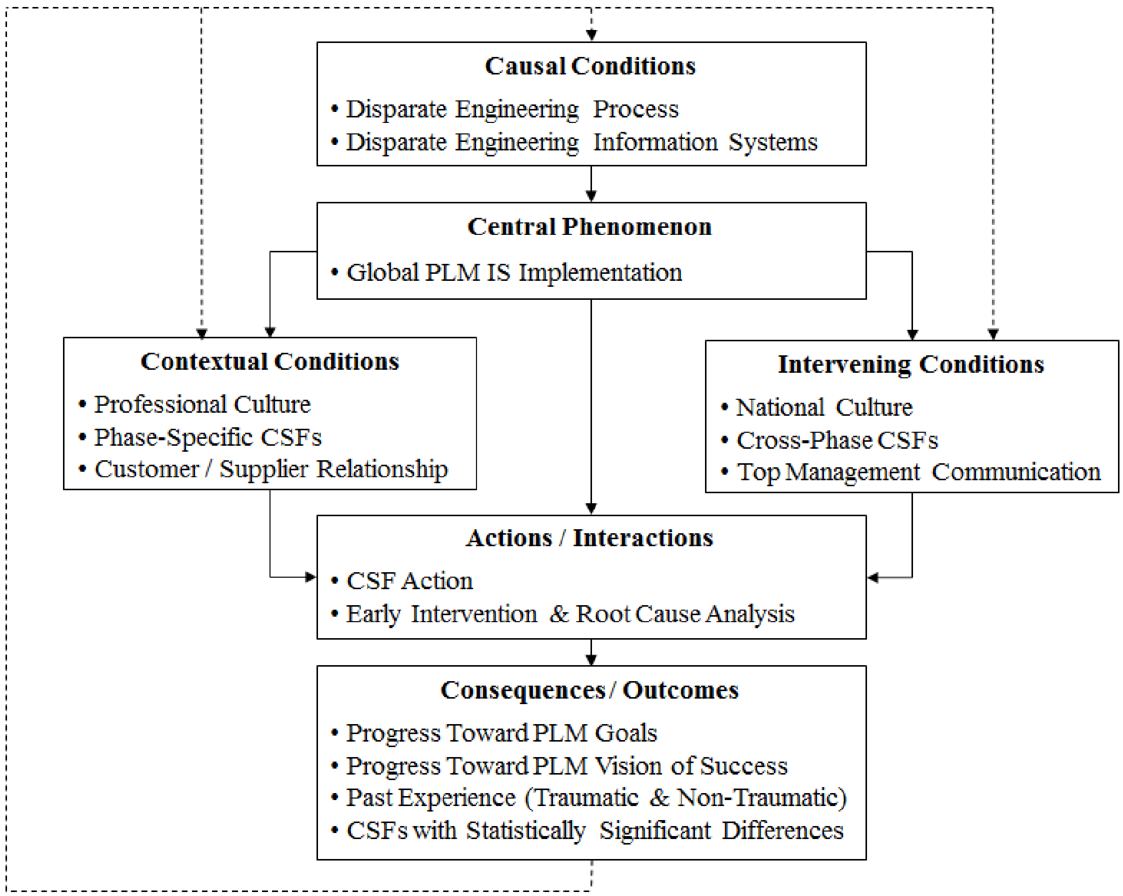

Figure 14. Focus Group – Preliminary Global PLM IS Implementation Framework

While this preliminary framework is based on a single instrumental case study requiring additional research for validation, the theory is grounded in the data and represents a robust model to guide and integrate global PLM IS implementations, culture, and CSFs.

RQ5: preliminary theoretical framework results summary.

RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs? To answer this research question, I built a theoretical framework based on selective coding from Strauss and Corbin (1998) and Morrow and Smith's (1995) grounded theory research. The data suggested three types of PLM CSFs that vary in essence: triggering (causal); phase-specific (contextual); and cross-phase (intervening). To populate the framework, I analyzed the nine hypotheses derived from the axial coding of the focus group transcripts. The net result was a closed loop framework that integrated global PLM IS implementation, culture, and CSFs.

Stage three: focus group results summary.

Stage three data collection was a focus group with the DMS Global PLM steering committee and focused on RQ3, RQ4, and RQ5. Five (three Japanese and two US) of the eight (62.50%) of the steering committee participated. The majority of the input, however, came from the US associates.

RQ3: What are the CSFs for global PLM IS implementation? The focus group concentrated on the top five ranked CSFs for each project phase. The steering committee recommended the addition of nine PLM CSFs and the removal of five. The dialog for RQ3 raised the following five hypotheses:

- H-01 Traumatic past experience identifies PLM CSFs with low quality outcomes.
- H-02 Early intervention improves PLM CSF outcomes.
- H-03 Top management communication overrides culture.
- H-04 There exist phase-specific PLM CSFs where importance is dependent on the project phase.

- H-05 There exist cross-phase PLM CSFs where importance is not dependent on the project phase.

RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation? The focus group concentrated on the 22 PLM CSFs with statistically significant differences based on the ANOVA by national and professional culture. The interchange of ideas among the steering committee generated the following four hypotheses:

1. H-06 Past Experience overrides culture.
2. H-07 Engineering associates have a bias toward rating PLM CSF importance higher than IT associates.
3. H-08 Customers (users) of an information system have a bias toward rating PLM CSF importance higher than suppliers of an information system.
4. H-09 PLM CSFs with statistically significant differences indicate potential problems worthy of additional management care.

RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs? The data suggested three types of PLM CSFs that vary in essence: triggering (causal); phase-specific (contextual); and cross-phase (intervening). To populate the grounded theory framework, I analyzed the nine hypotheses derived from the axial coding of the focus group transcripts. The net result was a closed loop preliminary theoretical framework that integrated global PLM IS implementation, culture, and CSFs.

Chapter 4 Results Summary

The data analysis proceeded according to the three stages of the research design and provided answers to the five research questions. The stage one in-depth steering committee interviews produced a vision of success statement for the DMS Global PLM project, documented

36 goals, and identified 20 PLM CSFs. During stage two, the project team completed a survey that rated the importance of the 20 PLM CSFs for each of the five project phases. An ANOVA based on culture found five PLM CSFs with statistically significant differences based on national culture, and 17 PLM CSFs with statistically significant differences based on professional culture. PLM CSFs with both a high importance rank and a statistically significant difference represent areas of potential conflict worthy of additional management consideration. The stage three steering committee focus group concentrated on the top five ranked CSFs and the ANOVA results. When considering the top five ranked PLM CSFs by project phase, the steering committee recommended the addition of nine PLM CSFs and the removal of five. An analysis of the focus group transcript identified nine relational statements, or hypotheses, which I incorporated into a closed-loop preliminary theoretical framework integrating PLM IS implementation, culture, and CSFs.

Chapter 5 Discussion

Introduction

This chapter discusses the results of the data collection and analysis. While the intent of chapter 4 was to present a broad and deep review of the results, the intent here in chapter 5 is to summarize patterns, trends, and outliers in the data. I begin with an analysis of the participant demographics. Next I discuss each research question respectively; noting not only alignment with the literature but also novel results. Following the examination of the research questions I describe limitations of the study. In response to limitations, I offer recommendations for further research. The chapter concludes with a summary.

Participant Demographics Discussion

As indicated in Figure 5, two populations were targeted for data collection by the three-stage mixed methods research design; the DMS Global steering committee, and the DMS Global project team. The populations were mutually exclusive. Collectively there were 32 participants; eight from the steering committee and 24 from the project team.

Limited past experience.

Of the 32 participants, 23 (71.88%) had no prior experience with global IS implementation. If the scope is narrowed global PLM IS implementations, then 30 (93.75%) had no prior experience. Thus the majority of the DMS Global PLM project participants were novices with respect to global PLM IS implementation. Their limited experience restricts their knowledge, understanding, familiarity, and foresight forcing them to react to the challenges associated with global IS implementation rather than anticipate challenges. Even if DMS Global could anticipate difficulties, their limited experience leaves them ill-equipped to mitigate problems, or to respond proficiently to issues which could not be averted.

Ironically, Past Experience (Lessons Learned) was one of the top five ranked CSFs for the first three project phases. Specifically, Past Experience (Lessons Learned) was the third most important CSF for engineers during phase 1 project preparation, the fifth most important CSF to US associates during phase 2 blueprint, and the second most important CSF for engineers during for phase 3 realization. Past experience was important but the participants had limited past experience.

Traumatic past experience.

It should be noted a subset of the US based DMS Global participants had experience with the implementation of the current (legacy) US based PLM IS and were able to articulate its shortcomings. For example, testing, training, and user satisfaction were identified in the focus group as weaknesses of the legacy PLM IS implementation (FG, ID-17, p. 10). The DMS Global strategy for coping with this weakness, however, was to begin work on weak areas earlier in the project lifecycle (FG, ID-17, p. 10; FG, ID-36, p. 39).

My professional experience has proved this approach fails to realize that improvements in outcomes are rarely driven by an earlier start. Doing more of something which failed to meet expectations does not result in met needs. More often, improvements in outcomes arise by changing the process and its inputs; not working longer or harder (Brynjolfsson and Hitt, 1998, p. 1-2). The participant response, while genuine and sincere, exposes their lack of familiarity with the implementation of enterprise level IS.

Participant demographics discussion summary.

In summary, the participant population lacked experience with global IS implementation in general and global PLM IS implementations in specific. Would the participant's lack of IS implementation experience, or the US participant's disappointing experience with the US based legacy PLM IS implementation affect the PLM vision of success? This research suggests the answer is, "Yes." The following section regarding the PLM vision of success justifies the affirmative answer.

RQ1: PLM Vision of Success Discussion

RQ1: How does vision of success for global PLM IS vary by culture? This researched focused on two dimensions of culture; national culture (Japanese and US) and professional culture (engineering and IT). I will discuss national culture first and professional culture second.

National culture.

Hofstede's et al. (2010) research on national culture suggested the Japanese would have a stronger long-term orientation, higher uncertainty (risk) avoidance, and a greater desire for collectivism. As anticipated by the literature, the Japanese were more risk adverse than the US and demonstrated a greater degree of harmony than the US in their PLM vision of success. The unanticipated result was the US participant's greater affinity for long-term orientation in their PLM vision of success.

What properties of the DMS Global case would cause the Japanese and US to supersede Hofstede's et al. (2010) research findings? Why were the US associates more focused on long-term results than the Japanese? The search for root causes led me to past experience; or lack thereof. The Japanese associates had no legacy PLM system. Their engineering information was primarily managed on a network file sharing platform. The US, however, had a legacy PLM IS which was not meeting expectations. The system was perceived as inflexible and cumbersome (i.e. not user friendly) by its users. I see the deficiencies of the US legacy PLM system as giving rise to future oriented vision of success themes. In other words, the unfavorable past experience of US legacy PLM IS users overrode Hofstede's et al. (2010) predictions regarding national culture.

Professional culture.

The academic literature made no predictions regarding professional culture. All participants who declined to comment regarding the PLM vision of success were engineers.

My approach toward professional culture was to divide participants based on function, or discipline. Engineering associates in one domain; IT associates in another domain. When discussing layers of culture, Hofstede et al. (2010), called this layer the "social class" which was associated with education, occupation, or profession (p. 18). During the focus group, one participant described the division of engineering and IT associates differently. He remarked, "I thought it was interesting to see the national differences or cultural differences US and Japan and also seeing the differences between IT and engineers in other words differences between users and suppliers" (FG, ID-09, p. 48).

Segregated view of IS implementation.

In this participant's mind, engineers were the users, or customers, of the PLM IS and IT associates were the suppliers of the PLM IS. I found this classification both insightful and informative. The dynamics of a customer / supplier relationship is fundamentally different than two partners working together to achieve a common goal. If engineering is the customer, "purchasing" a PLM IS from an IT supplier, then the engineer would be in the sole position to judge the friendliness and value of the system. The engineer would establish requirements to be satisfied by the IT supplier. Engineering orders and IT responds. This is a segregated view of IS implementation rather than an integrated view.

This customer / supplier paradigm places engineering in a more powerful position than IT. This model segregates engineering and IT. This view of the relationship may lead to interactions that are formal, distant, and at "arms-length." I wholeheartedly agree engineering is the primary user of the PLM IS and is entitled to a system that meets their needs. Nevertheless, the customer / supplier configuration is radically different than two equal partners jointly striving towards a mutually agreed common goal. Further, I wonder if the DMS Global IT associates are cognizant of the customer / supplier perspective and are willing to accept what Hofstede et al. (2010) defined as "… power distance … the extent to which the less powerful members of institutions and organizations within a country expect and accept that power is distributed unequally" (p. 61).

RQ1: PLM vision of success discussion summary.

In summary, the US participants unfavorable past experience with the legacy PLM IS implementation superseded Hofstede's et al. predication of national culture tendencies. Past disappointment heightened sensitivity. Further, the cultural dimension of power distance emerged from the focus group dialog which positioned engineering as system users / customers, and IT as system supplier. It follows that a dissatisfied, or unhappy customer, is more difficult to please than a satisfied customer. In the following section, I will support how the findings related to traumatic past experience, and a segmented view of IS repeated in the discussion of goals.

RQ2: PLM Goals Discussion

RQ2: How do goals for global PLM IS vary by culture? Like RQ1, RQ2 considered both national and professional culture. The discussion of national culture is presented first followed by my observations regarding professional culture. Following the cultural assessment, I raise one additional observation: confusion regarding vision and goals.

National culture.

As previously noted, Hofstede's et al. (2010) research on national culture suggested the Japanese would have a stronger long-term orientation, higher uncertainty (risk) avoidance, and a greater desire for collectivism. The DMS Global results, however, were not aligned with Hofstede's et al. (2010) predictions. As with RQ1: (vision of success) the US associates demonstrated a stronger long-term orientation than Japan in their statements regarding PLM IS implementation goals. My explanation for this recurrence was again past experience. Both the Japanese and US PLM goals were risk-adverse. The source of the low US tolerance from risk is likely deficiencies in the legacy US PLM IS. The Japanese and the US were equally diverse in their PLM goal statements.

Of the nine participants who declined to answer the survey questions related to goals, one third (33.33%) were Japanese participants and two thirds (66.67%) were US participants. I was surprised by the willingness of Japanese associates to offer PLM IS implementation goals. In my experience working with Japanese associate, I found they exercised great caution to avoid deviation from the direction set by senior leadership. Why then were Japan associates willing to offer new PLM goals?

As I reflected on this question within the context of this case study I arrived at three potential root causes. First, the openness in Japanese responses occurred during the stage two survey data collection and analysis. The survey provided anonymity which may have fostered candid communication. Second, it is possible Japanese associates viewed comments regarding the PLM visions of success as deviation from senior leadership direction, but viewed comments regarding PLM goals as supporting, or enabling, the vision of senior leadership. Third, and finally, perhaps Japanese associates were eager to express PLM goals because they would be system users and therefore wanted to ensure the system met their needs. These potential root causes are speculation that would require further research to confirm.

Having considered national culture, I turned to professional culture.

Professional culture.

The professional culture mix of the participants who did not answer survey question 4.1 regarding goals was six (66.67%) engineers and three (33.33%) IT. While not predicted by Hofstede et al. (2010), this matched my professional experience with engineers; that is they are precise individuals and unwilling to provide ambiguous responses. There was evidence of confusion regarding vision of success and goals.

Confusion regarding vision of success and goals.

For both national and professional culture, the data suggests it was difficult for participants to distinguish between the vision of success and goals. The data collection protocols defined vision of success as general statements about what the PLM system will do for DMS Global when implemented. This definition was an adaptation of Bullen and Rockart's (1981) definition of objectives; "… general statements about the direction in which a firm intends to go, without stating specific targets to be reached at particular points in time" (p. 8). The protocols defined goals as specific targets to be met in a period of time to realize the PLM project vision of success. My definition of goals mirrored Bullen and Rockart's (1981) definition which stated goals are "… specific targets to be reached at a given point in time. The goal is thus an operational transformation of one or more objectives" (p. 8). Hence the vision leads to goals and the goals support, or realize, the visions of success.

As noted above, despite these operational definitions, it was difficult for participants to differentiate between the PLM vision of success and PLM goals. For example, one US steering committee participant stated:

> To me, I have a very difficult time creating the line of demarcation relative to vision of success versus the goals. To me basically, the goals are to achieve the vision of success within the required time period (DI, ID-22, p. 14).

A different US steering committee member simply listed the project phases as the PLM goals (DI, ID-32, p. 13). Similarly, project team responses to the stage two surveys indicated confusion regarding the PLM vision of success and goals. For example, the survey response raised ten new goal categories or themes which were not identified during the stage one in-depth interviews. Of the ten new PLM goals, eight (80%) were actually related to the PLM vision of success because they described what the PLM system will do for DMS Global when implemented.

RQ2: PLM goals discussion summary.

In summary, the discussion of goal data by national and professional culture provided interesting results in two areas. First, the participants did not match Hofstede's et al. (2010) predictions regarding national culture. It appears that unfavorable past experience with the legacy US PLM IS overrode Hofstede's et al. (2010) expectations. Second, the participants struggled to differentiate between vision of success and goals.

RQ3: PLM CSFs Discussion

RQ3: What are the CSFs for global PLM IS implementation? The answer to this research question proceeded according to the three-stages of data collection and analysis:

- Stage One: identification of PLM CSF from the in-depth interviews.

- Stage Two: rating of CSFs importance by project phase in the survey.
- Stage Three: examination of the top five ranked CSFs during the focus group.

The discussion of PLM CSFs is organized according to the same three steps.

Stage one: in-depth interview identification of PLM CSFs.

The first stage was to review the in-depth interview for PLM CSFs. My analysis found 20 (and the focus group recommended a 21st CSF). Cantamessa et al. (2012) claimed the ERP body of literature may not be directly applicable to PLM IS implementation (p. 192). This begged the question: *Would the CSFs for PLM be different than the CSFs for ERP*. The findings indicate the answer to this question was no because 19 of the 20 (95.00%) PLM CSFs had also been identified by the ERP literature. The one outlier was PLM CSF 08 Global Integrated System. Given these results, I recommend no further research regarding the identification of CSFs for PLM; the ERP CSFs are comprehensive. Future PLM research should simply reuse the PLM CSFs identified by this study, or one of the many lists of ERP CSFs.

Stage two: survey rating of CSF importance by project phase.

The second stage was to have the project team complete a survey that rated the importance of all 20 PLM CSFs for each of the five project phases in the survey. Mean importance ratings and standard deviations were calculated from survey responses for each of the 20 PLM CSFs by project phase. The PLM CSFs were then ranked from one to 20, where rank number one was the CSF with the highest mean importance rating. If two, or more, CSFs had the same mean importance, they were given the same rank.

Rockart (1979) recommended the number of CSFs should be limited (p. 85). Davis (1979) claimed humans had a limited short term capacity for processing information and would experience difficulty focusing on more than seven to nine CSFs (p. 57). In his 1982 case study, Rockart (1982) consolidated 50 CSFs to four (p. 8). I chose to limit my analysis to the top five ranked CSFs for each project phase. Specifically, the CSFs were sorted by descending mean importance. The CSF with the highest mean was given rank 1.

Top five ranked PLM and ERP CSF outlier analysis.

The first analysis I performed was to compare the top five ranked PLM CSFs with the top five ranked ERP CSFs by project phase. For the ERP data I turned to Somers and Nelson (2001) who had performed a similar study where survey respondents rated the importance of 22 ERP CSFs by project phase (p. 7). I compared the top five ranked CSFs for both PLM and ERP; summary results are presented in Table 31.

Table 31. Discussion – Aggregate Culture – CSFs PLM & ERP Comparison

Project Phase	PLM CSF Only	Common CSF	ERP CSF Only	Total
P1 Project Prep.	2	3	2	7
P2 Blueprint	3	2	2	7
P3 Realization	7	-	5	12
P4 Final Prep.	4	1	5	10
P5 Go Live & Sup.	4	1	4	9
Total	20	7	18	45
% of Total	44.44%	15.56%	40.00%	100.00%

Note. PLM CSF Only = the count of top five ranked PLM CSFs which were unique to PLM for the project phase, Common CSF = count of top five ranked CSFs that were common to both PLM and ERP, ERP CSF Only = the count of top five ranked ERP CSFs which were unique to ERP.

Table 31 shows only 7 of 45 (15.56%) of the top five ranked CSFs by project phase for PLM and ERP are common. This was unexpected given the PLM CSFs were a subset of the ERP CSFs. What would cause a difference between PLM and CSF importance by project phase? The search for an answer to this question led me to two root causes: inexperience and past traumatic experience.

Limited past experience.

The first root cause found was the inexperience of DMS Global with global IS implementation. For example, CSF 17 Testing was a top five ranked CSF in P5 Go Live & Support, however testing is completed earlier in P3 Realization. Similarly, CSF 20 User Satisfaction did not appear in the top five ranked CSFs until P5 Go Live & Support. At this point in the project lifecycle, the PLM system has gone live and it is too late to address user satisfaction concerns. The proper time to consider user satisfaction concerns is during the design of business processes in P2 Blueprint.

Why then would DMS Global participants ascribe high importance to testing and user satisfaction in phase five? Because this is when they feel the pain; at go live. Further, their limited past experience did not equip them with the ability to solve the problem. They could only detect the problem. To solve the felt problem in P5, the project team would need to move from problem to the root cause(s) and modify the process in the earlier project phases to produce the desired outcomes. This lack of insight heightens the significance of traumatic past experience.

Traumatic past experience.

The second root cause was the US associates unsatisfactory past experience with their legacy PLM IS. For example, training on the legacy PLM IS was problematic (FG, ID-17, p. 10). This traumatic past experience heightened sensitivity to the problem and triggered risk mitigation actions. For example, PLM CSF 19 Training was a top five ranked CSF for three project phases even though training is concentrated in P4 Final Preparation. In this instance, the risk mitigation was an overreaction to past problems. Traumatic past experience, therefore, is an indicator of problems, but does little to provide solutions.

Top management CSF recurrence analysis.

The second, and final, analysis I conducted was to examine the recurrence of PLM CSF 18 Top Management Support by project phase. The motivation for the focus on top management support was Dong, Neufeld, and Higgins' (2009) study which reinforced the established link between strong top management support and ERP IS implementation success (p. 55). For a method to perform this analysis I again turned to the study of Somers and Nelson (2001) which found the ERP CSF top management support was ranked in the top five for all but the P3 Realization phase (p. 7). Particularly, for companies implementing ERP, top management support was vital during P1 Project Preparation, P2 Blueprint, P4 Final Preparation, and P5 Go Live & Support. Conversely for DMS Global, PLM CSF 18 Top Management Support ranked in the top five only during P1 Project Preparation, and P2 Blueprint. For DMS Global top management was not vital during P4 Final Preparation and P5 Go Live & Support.

My professional experience with the implementation of more than 70 IS confirmed that top management support is essential during P4 Final Preparation and P5 Go Live & Support. For example, during P4 Final Preparation the new IS becomes tangible to the end user through hands-on training. This exposure to the new IS often causes organizational stress. Top management support, realized through empathetic communication and adjustment of resource allocation (i.e. making time and money available for training), calms and dissipates stress. DMS Global identified poor training on the legacy US PLM IS as a past problem, but failed to make the connection between training and top management support. Why did DMS Global miss the cause-and-effect relationship? The answer is twofold.

Limited past experience.

The first reason top management support did not recur in P4 Final Preparation and P5 Go Live & support is the limited global IS implementation experience of the participants. They simply did not know any better.

Segregated view of IS implementation.

The second reason top management support did not recur in P4 Final Preparation and P5 Go Live & support is a segregated view of the IS, rather than an integrated view. The concept of segregated versus integrated perspectives of IS was introduced in the discussion of RQ1: (vision of success) using the metaphor of customers (engineering) and suppliers (IT) working on the DMS Global PLM project. The top five ranked PLM CSF recurrence analysis found top management support is required to fund the project (P1 Project Preparation) and to ensure a robust design (P2 Blueprint). After the first two phases, however, top management support was no longer critical implying the implementation of a common global PLM IS transitions from a business project to an IT project after phase 2.

One focus group participant commented, “I figured [top management support was required] only until the ARA [asset request authorization] is signed [Laughter]” (FG, ID-17, p. 28). To be impartial, the focus group participant did note, “Truly, I thought it [i.e. top management support] would be important to get the project launched and then the middle I thought was basically core team and others, and then I actually thought it should be of importance for the roll out” (FG, ID-18, p. 28). Nevertheless, even this second quote suggests the segmented view of IS implementation.

Stage three: focus group examination of top five ranked CSFs.

The third stage was to examine PLM CSF importance during the focus group. The focus group concentrated on the top five ranked CSFs by project phase from the project team survey. They identified 14 changes to PLM CSF importance and made five relational statements, or hypothesis, regarding PLM CSF importance. I will first discuss the 14 changes, and then the five hypotheses.

Focus group changes to PLM CSF importance by project phase.

Through the course of their discussion, the focus group recommended 14 changes to the top five ranked PLM CSFs by project phase as summarized in Table 29. The changes can be classified in three groups; net additions, net deletions, and changes.

Net additions are PLM CSFs added to Table 29 that were not identified by the earlier survey as a top five ranked CSF for any project phase. Net addition created a new row in Table 29. The focus group net additions were:

- 09 Goals & Objectives (Scope)
- 14 Project Team (Resources)
- 11 Past Experience (Lessons Learned)
- xx Go Live User Support

These CSFs were vitally important to the focus group. One CSF, xx Go Live User Support, was a new CSF, leading to 21 rather than 20 PLM CSFs. The net additions occurred at the bookends of the project; in the first two project phases (P1 Project Preparation and P2 Blueprint), and the last project phase (P5 Go Live & Support).

Net deletions are the opposite of net additions. They represent the removal of a row from Table 29, or the deletion of a PLM CSF from the top five rank for all project phases. The one net deletion was:

- 06 Customer Satisfaction

The focus group dialog indicated confusion regarding this PLM CSF. For example, one participant noted, "…the desire for customer satisfaction was a major consideration but I don't know how to interpret it" (FG, ID-22, p. 14).

Changes by phase neither added, nor deleted, a row in Table 29, but rather modified the phase in which an existing PLM CSFs was ranked in the top five. The six changes by phase were:

- 18 Top Management Support
- 13 Project Management
- 03 Change Management
- 17 Testing
- 07 Data Conversion
- 20 User Satisfaction

I reviewed all CSF modifications recommended during the focus group meeting by project phase. No patterns emerged. Of the 14 changes, nine were additions and five were deletions resulting in a net increase of four in the listing of top five ranked PLM CSFs by project phase. The changes, however, indicate the focus group was engaged in the dialog surrounding PLM CSF importance. Further, the dialog regarding importance surfaced several relational statements, or hypotheses.

Focus group PLM CSF importance hypotheses.

Below are the five hypotheses resulting from the focus group dialog regarding PLM CSF importance:

- H-01 Traumatic past experience identifies PLM CSFs with low quality outcomes.
- H-02 Early intervention improves PLM CSF outcomes.
- H-03 Top management communication overrides culture.
- H-04 There exist phase-specific PLM CSFs where importance is dependent on the project phase.

- H-05 There exist cross-phase PLM CSFs where importance is not dependent on the project phase.

In the following paragraphs I will discuss the implications of each hypothesis in turn.

H-01 Traumatic past experience identifies PLM CSFs with low quality outcomes. Unfavorable past experience is a triggering CSF; analogous to a warning light on the dashboard of a motor vehicle. It signals that some parameter is not within specification or a given outcome is problematic. Past experience, however, does not resolve the problem; it merely indicates the presence of, or potential for, a defect. It should cause an action / interaction to remedy the issue; perhaps triggering another PLM CSF. The primary action suggested by the focus group for a problematic PLM CSF was early intervention.

H-02 Early intervention improves PLM CSF outcomes. This hypothesis is valid if the root cause of the problem was simply a lack of time. My experience, however, has demonstrated that improving outcome is rarely as simple as investing more time. Working harder is not as effective as working smarter. To work smarter requires first identifying root causes of the defect, then adjust the process and its input to eliminate, or mitigate, the chance of shortcomings. Here I found a recurrence of the need to understand lead and lag measures, determinism, and leverage. People will need to do something differently to improve the quality of outcomes. Quality starts at the top (Gygi, 2012, pp. 48–49). Top management communication is a powerful tool for communicating vision and aligning resources toward a common goal.

H-03 Top management communication overrides culture. Having worked on the DMS Global project for one and one half years, I was keenly aware of the challenges associated with harmonizing engineering processes and IS. Hence, I was surprised when PLM CSF 02 Business Process Reengineering (BPR) Common Processes was ranked second for the P1 Project

Preparation Phase, and ranked first for P2 Blueprint Phase. When I questioned the focus group why they believed this PLM CSF was ranked so highly one participant replied:

> I think that if you go back to the top CSF, being common business practices, that is a strong message passed down from top management and it is also a quality objective, you know it is very prevalent in our culture here. I think people… you know, the message is working. (FG, ID-17, p. 33)

Accordingly, top management communication can override culture, or intervene, modifying routine action / interaction. Regardless, there are CSFs were importance is driven by project phases.

H-04 There exist phase-specific PLM CSFs where importance is dependent on the project phase. An alternate formation of this hypothesis is: there exists context-specific PLM CSFs where importance is dependent on the context of the project phase. For example, PLM CSF 17 Testing would be important during P3 Realization because this is where system verification occurs. Conversely, testing during P1 Project preparation is premature; and testing during P5 Go Live & Support is overdue. Another example of a phase-specific PLM CSF is 07 Data Conversion which is concentrated in P4 Final Preparation and P5 Go Live & Support. When I considered the fundamental nature, or essence, of the phase-specific PLM CSFs I found they were tangible, concrete, and focused on direct integration with the IS and its data. Perhaps the essence of cross-phase PLM CSFs would be different.

H-05 There exist cross-phase PLM CSFs where importance is not dependent on the project phase. The most prominent example of a cross-phase PLM CSF in Table 29 is 13 Project Management which was ranked in the top five for all but P1 Project Preparation. In other words, once project preparation is complete, project management is important for the remainder of the project lifecycle. Another example is 18 Top Management Support which recurred in three project phases. Project management and top management support do not directly interact with the IS or its data; they are more abstract. The importance cross-phase PLM CSFs is associated with their ability to influence, trigger, override, or intervene.

RQ3: PLM CSFs discussion summary.

In summary, the discussion of PLM CSFs yielded interesting results in four areas. First, the PLM CSFs were a subset of the ERP CSFs. Accordingly, I recommend future research regarding PLM CSFs reuse the list of PLM CSFs developed by this study, or one of the many lists of ERP CSFs. Second, many of the themes which surfaced during the discussion of vision of success and goals recurred during the focus group. For example, the following subjects reemerged: limited past experience; traumatic past experience, segregated view of IS; lead and lag measures; determinism; and leverage. Third, the evaluation of PLM CSFs raised five relational statements, or hypothesis. Fourth, and finally, a deeper examination of the hypotheses engendered three types of PLM CSFs: triggering (causal), phase-specific (contextual), cross-phase (intervening). The types of PLM CSFs (triggering, phase-specific, and cross-phase) had a direct correlation to Strauss and Corbin's (1998) classification of conditions (causal, contextual, and intervening) (pp. 131–132). The following section discusses the impact of culture on PLM CSFs.

RQ4: PLM CSF Importance by Culture Discussion

RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation? This discussion of results will concentrate on two areas: ANOVA from the project team survey, and four new hypotheses generated by the focus group. I will begin with the survey ANOVA, and then move to focus group hypotheses.

Survey analysis of variance (ANOVA).

Two dimensions of culture were considered; national (Japanese and US) and professional (engineering and IT). The ANOVA found 22 PLM CSFs with statistically significant differences; five (22.73%) based on national culture and 17 (67.27%) based on professional culture. The ratio of five to 17 did not surprise the Japanese participants, but it was an unexpected result for the US participants. One US associates commented, "From my vantage point, I was just a little bit surprised that there were more of a professional cultural difference than a national" (FG, ID-22, p. 31). Table 32 summarized the PLM CSFs with statistically significant differences by project phase and culture. The data in the cells of Table 32 are defined as follows:

- JP X, where X indicates the rank assigned to the CSF by Japanese participants.
- US X, where X indicates the rank assigned to the CSF by US participants.
- ENG X, where X indicates the rank assigned to the CSF by engineering participants.
- IT X, where X indicates the rank assigned to the CSF by IT participants.
- Cells shaded in gray indicate this was a top five ranked CSF by one, or both, cultures.
- Sig. is the significance value from the ANOVA.

Table 32. Discussion – CSFs Likely to Generate Conflicts

PLM CSF	National Culture	Professional Culture	Sig.
P1-03 ChangeMgmt	JP 9, US 3		.044
P1-09 GoalsObjectives		ENG 14, IT 3	.037
P1-11 PastExpLessonsLearn		ENG 3, IT 18	.033
P1-14 ProjTeamResources		ENG 12, IT 1	.006
P1-18 TopMgmtSupport	JP 9, US 1		.001
P3-11 PastExpLessonsLearn		ENG 2, IT 18	.017
P3-12 PLMSysEvalSelect		ENG 17, IT 20	.047
P3-17 Testing	JP 19, US 1		.000
P3-20 UserSatisfaction	JP 19, US 6		0.27
P4-06 CustSatisfaction		ENG 3, IT 10	.048
P4-09 GoalsObjectives		ENG 13, IT 18	.028
P4-10 ImplementStrategy		ENG 9, IT 18	.012
P4-11 PastExpLessonsLearn		ENG 9, IT 17	.027
P4-12 PLMSysEvalSelect		ENG 19, IT 19	.043
P4-16 TimeSchedule		ENG 1, IT 10	.037
P4-19 Training	JP 6, US 1		.050
P5-04 ConsultSysIntegrator		ENG 7, IT 20	.003
P5-09 GoalsObjectives		ENG 16, IT 16	.036
P5-10 ImplementStrategy		ENG 7, IT 15	.015
P5-11 PastExpLessonsLearn		ENG 3, IT 17	.004
P5-17 Testing		ENG 4, IT 13	.028
P5-20 UserSatisfaction		ENG 1, IT 7	.030

While all the PLM CSFs in Table 32 represent areas of potential conflict, applying the principle of leverage, I recommend DMS Global focus on the PLM CSFs shaded in gray because these represent top five ranked PLM CSFs with statistically significant differences. A disagreement on the importance of top five ranked PLM CSF is more substantial than a disagreement on a bottom five ranked PLM CSF. For example, in P3 Realization, PLM CSF 11 Past Experience Lessons Learn was rank 2 for engineers and rank 18 for IT. Conversely, in P3 3 Realization, PLM CSF 12 PLM System Evaluation & Selection was rank 17 for engineers and rank 20 for IT. In this example, the statistically significant difference regarding the importance of PLM CSF 11 Past Experiences Lessons Learned is more concerning than the statistically significant difference for PLM CSF 12 System Evaluation and Selection.

Accordingly, the ranking of PLM CSFs and ANOVA identified PLM CSFs worthy of additional management care. This sentiment was captured in one of the four hypothesis found during the focus group meeting.

Focus group hypotheses.

The focus group resulted in the identification of the following four relational statements, or hypotheses:

- H-06 Past Experience overrides culture.
- H-07 Engineering associates have a bias toward rating PLM CSF importance higher than IT associates.
- H-08 Customers (engineering users) of an information system have a bias toward rating PLM CSF importance higher than suppliers (IT) of an information system.

- H-09 PLM CSFs with statistically significant differences indicate potential problems worthy of additional management care.

While similar, I included H-07 and H-08, because the focus group used both sets of terminology. In the following paragraphs I will discuss the implications of each hypothesis in turn.

H-06 Past Experience overrides culture. Hofstede et al. (2010) forecasted the Japanese would have a stronger long-term orientation, higher uncertainty (risk) avoidance, and a greater desire for collectivism when compared to the US. The data indicates, however, US participants are more risk-adverse. For example, considering the data in Table 32, the US gave a higher importance rank to all five of the PLM CSFs with statistically significant differences. When I probed for root causes during the focus group, one participant commented:

> The difference in the testing between the US and Japan I think it is due to the fact that the US had the experience of implementing [a legacy PLM system], and therefore you were able to take advantage of that. So you viewed the importance of, you recognized the importance of, testing more. (FG, ID-36, p. 39)

Past experience overrode tendencies observed by Hofstede et al. (2010). The past experience triggered, or caused, a higher importance ranking of PLM CSFs.

H-07 Engineering associates have a bias toward rating PLM CSF importance higher than IT associates. One focus group participant observed there appeared to be a cultural bias in the rating of importance (FG, ID-22, p. 49). Similarly, another participant, when considering the 17 CSFs with statistically significant differences in Figure 20, observed, “The engineers are 5.5 across the board. Their mean is pretty even for each one; too conservative to say something is not important” (FG, ID-17, p. 46).

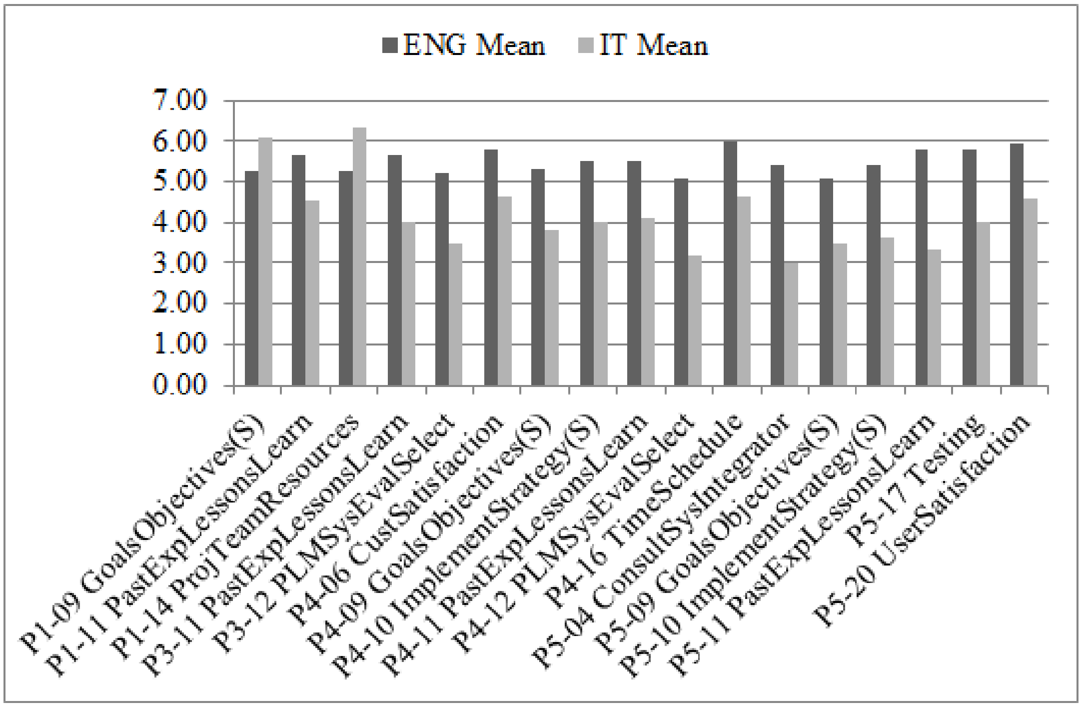

Figure 15. Discussion – Professional Culture – CSFs with Significant Differences

For all but two PLM CSFs (i.e. P1-09 Goals & Objectives and P1-14 Project Team Resources), engineers had higher mean importance than IT. The focus group requested an analysis of the mean importance of all 20 PLM CSFs for all five project phases stratified by engineering and IT. I performed the requested analysis. Table 33 presents the findings of the engineering bias analysis:

Table 33. Discussion – Engineering Bias Analysis

Project Phase	PLM CSFs with Higher Mean Importance Assigned by Engineering	PLM CSFs with Higher Mean Importance Assigned by IT
P1 Project Preparation	8 (40%)	12 (60%)
P2 Blueprint	18 (90%)	2 (10%)
P3 Realization	17 (85%)	3 (15%)
P4 Final Preparation	17 (85%)	3 (15%)
P5 Go Live & Support	18 (90%)	2 (10%)
Total	78 (78%)	22 (22%)

The data in Table 33 supports H-07 Engineering associates have a bias toward rating PLM CSF importance higher than IT associates in all but P1 Project Preparation.

H-08 Customers (engineering users) of an information system have a bias toward rating PLM CSF importance higher than suppliers (IT) of an information system. One participant framed engineering and IT culture as customer and supplier:

> I grouped them. I thought that the user satisfaction, testing, past lessons learned and even to a lesser extent the consultation system integrator and the implementation strategy were all reflective of user environment. I'll call them voice of customer concerns. And, to me I was surprised and I think it's concerning that basically engineers who are the customers are saying these are all important issues and IT is saying they're not. (FG, ID-22, 45).

This quotation reiterates the segregated view of IS implementation held by DMS global. This view moves the engineering / IT relationship from one of equal partner striving toward a common goal to what Hofstede et al. (2010) defined a power-distance relationship where engineering is in a more powerful position than IT (p. 61). As a result, conflict can arise from different expectations regarding command and control; especially related to PLM CSFs with statistically significant differences.

H-09 PLM CSFs with statistically significant differences indicate potential problems worthy of additional management care. While there was discussion regarding the validity of the analysis of variance due to the bias in the engineering PLM CSF important ratings, the focus group did agree that PLM CSF with statistically significant differences represent areas of potential conflict worthy of additional management care. For example, one participant noted, "To me, I still just think it is a critical indicator" (FG, ID-22, p. 46). Further, based on a review of Table 32, which summarized the PLM CSFs with statistically significant differences by project phase and culture, DMS Global would be wise to focus management attention on the following five PLM CSFs which were ranked number 1 in importance:

- 14 Project Team Resources: engineering rank 12, IT rank 1
- 17 Testing: Japan rank 19, US rank 1
- 16 Time Schedule: engineering rank 1, IT rank 10
- 19 Training: Japan rank 6, US rank 1
- 20 User Satisfaction: engineering rank 1, IT rank 7

RQ4: PLM CSF importance by culture discussion summary.

In summary, the discussion regarding the impact of culture on PLM CSFs produced thought-provoking results in two areas. First, there were 22 PLM CSFs across the five project phases with statistically significant difference in their importance ratings based on culture. Theses CSFs represent areas of potential conflict among culture groups worthy of additional management oversight. The distribution of 22 PLM CSFs with statistically significant differences was five (22.73%) based on national culture and 17 (67.27%) based on professional culture. This was surprising to me, and proved the value of the grounded theory method used in this research to mitigate my bias. Second, the evaluation of the impact of culture on PLM CSF importance developed four additional hypotheses. The five hypotheses from RQ3: and the four hypotheses from RQ4: became the foundation of the preliminary theoretical framework integrating PLM IS implementation, culture, and CSFs.

RQ5: Preliminary Theoretical Framework Discussion

RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs? The answer to this research question synthesized the results of the prior four research questions into the grounded theory framework displayed in Figure 16. The discussion of the theoretical framework will encompass the following seven topics:

1. Integration of the CSF method and Grounded Theory
2. Causal Conditions
3. Central Phenomenon
4. Contextual Conditions
5. Intervening Conditions
6. Action / Interaction
7. Consequences / Outcomes

The first topic provides general observations regarding the framework. The remaining six topics address the individual components of the framework.

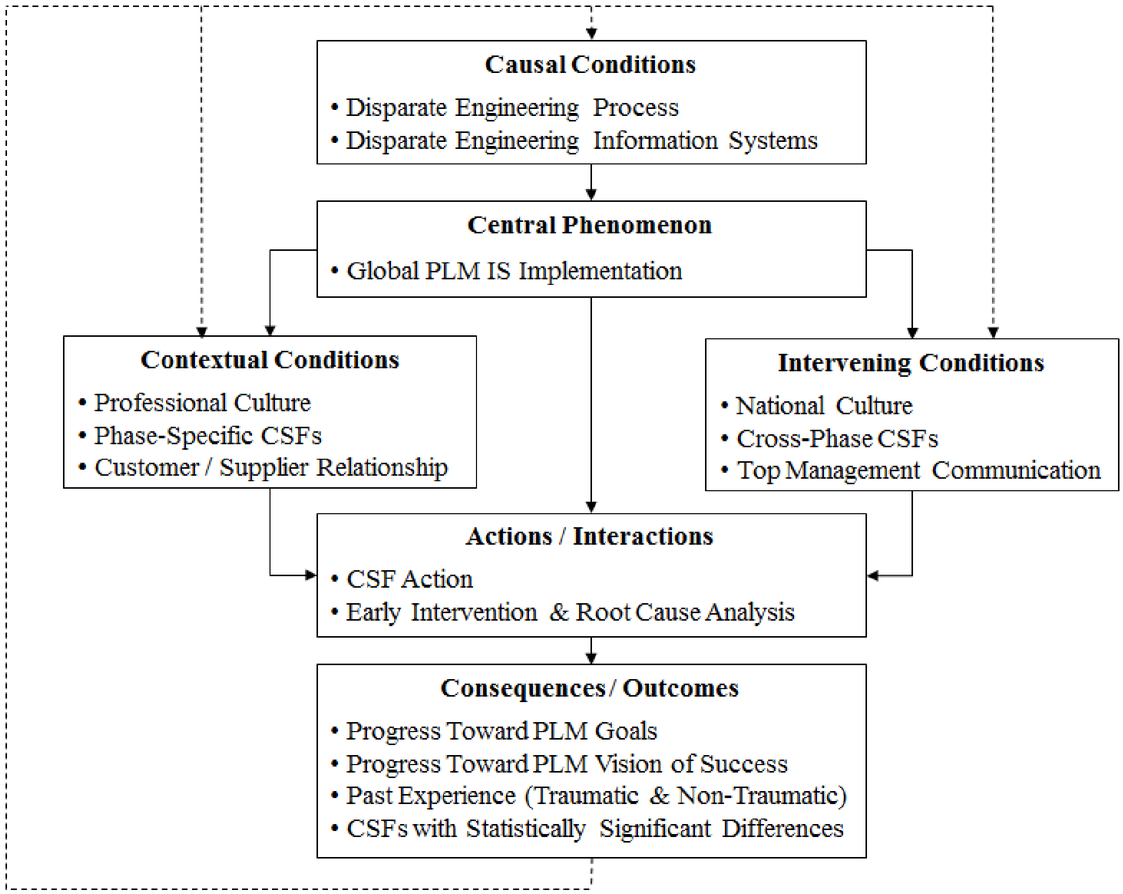

Figure 16. Discussion – Preliminary Global PLM IS Implementation Framework

Integration of the CSF method and grounded theory.

The preliminary theoretical framework (Figure 16) merges Rockart's (1979) CSF method and Strauss and Corbin's (1998) grounded theory axial coding paradigm. In Rockart's (1979) CSF method, the flow is bidirectional as illustrated in Figure 17 which I created. The forward flow is strategic and constraining in nature as the vision of success spawn goals and goals spawn CSFs. The backward flow is tactical and deterministic in nature as CSFs realize goals and goals realize the vision of success.

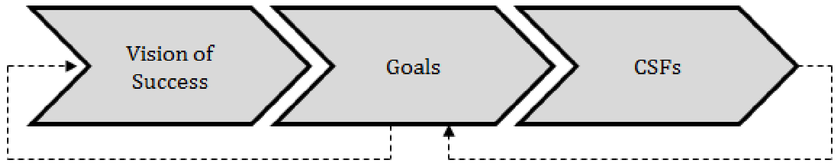

Figure 17. Discussion – Rockart's CSF Method

CSFs act as lead measures that predict the outcome of the goals and vision of success. CSFs are deterministic in nature and provide leverage to the IS implementation team. By focusing management attention on a limited number of the most critical success factors, the project team maximized their influence on the outcome of the initiative.

Strauss and Corbin's (1998) axial coding paradigm is comprised of conditions, actions / interactions, and outcomes associated with a central phenomenon as depicted in Figure 18 which I created (p. 128).

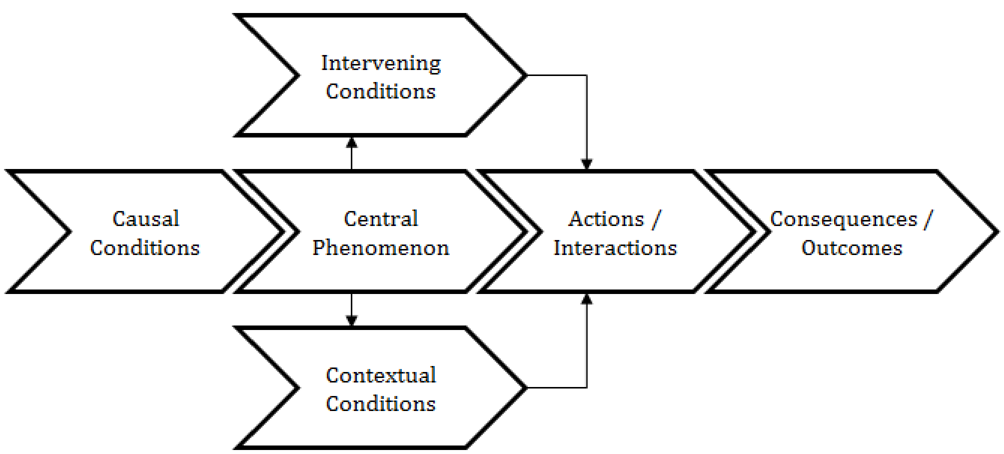

Figure 18. Discussion – Strass & Corbin's Expanded Axial Coding Paradigm

The flow is from conditions to actions / interactions to consequences. Conditions are defined as, "sets of event or happenings that create the situations, issues, and problems pertaining to a phenomenon …" (Strauss & Corbin, 1998, p. 130). Conditions are further classified as causal (those that give rise to, or influence the central phenomenon), contextual (narrow in scope, episodic in nature, and bound by time and place), and intervening (broad in scope, constant in nature, not bound by time and place, altering the impact of causal and contextual conditions) (Creswell, 2007, pp. 64–65; Strauss & Corbin, 1998, pp. 131–133). In Figure 18 I have added lines from the central phenomenon to intervening and contextual conditions to indicate the influence the central phenomenon exerts on these types of conditions. For example the global PLM IS implementation affected contextual phase-specific CSFs and intervening top management communication.

A comparison of Rockart's (1979) CSF method with Strauss and Corbin's (1998) grounded theory axial coding paradigm led to the integrated model displayed in Figure 19.

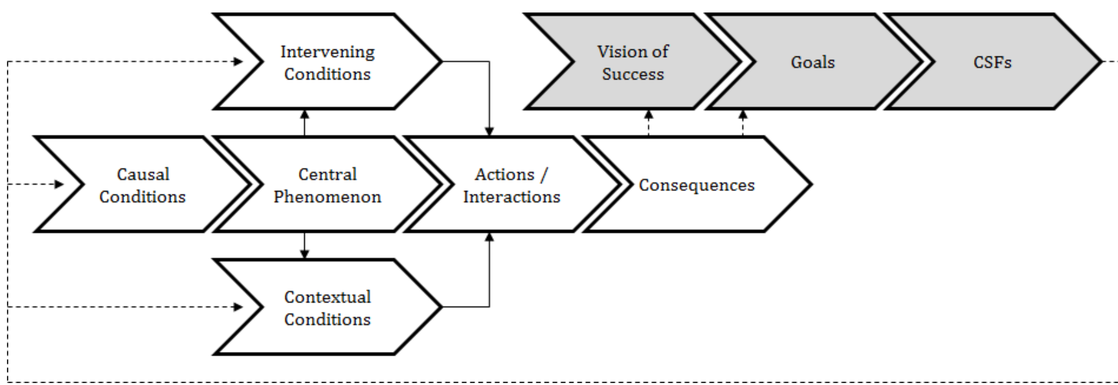

Figure 19. Discussion – Integrated CSF Method & Grounded Theory Model

There are three noteworthy items arising from the integration of the CSF method and grounded theory axial coding paradigm. First, the model is aligned with the vision of success. The consequences are not merely a response to the actions / interactions arising from conditions, but rather consequences are compared with attainment of the vision of success. Second, the model is closed-loop. The vision of success drives the goals, the goals drive the CSFs, CSFs influence conditions (intervening, causal, and contextual), which give rise to actions / interactions, which yield consequences that close-the-loop when they are compared with the vision of success. Third, the model embodies the principles of lead and lag measures, determinism, and leverage.

Having considered the essence of the theoretical framework integrating PLM IS implementations, culture, and CSFs in Figure 16, the following sections discuss each element of the framework respectively.

Causal conditions.

Causal conditions are defined as sets of events or happenings that give rise to, or influence the central phenomenon (Creswell, 2007, p. 64; Strauss & Corbin, 1998, p. 131). This relationship is reflected in the arrow from causal conditions to the central phenomenon in Figure 16. DMS Global recognized two causal conditions: disparate engineering processes and disparate IS (DMS Global, 2010, p. 9). The legacy processes and IS were a barrier to enterprise growth. In other words, past experience was the primary causal condition triggering the global PLM IS implementation. Further, past experience, both traumatic and non-traumatic, altered the understanding of how best to approach the implementation; producing CSFs with statistically significant differences. These relationships are made explicit in the preliminary global PLM IS implementation framework (Figure 16) by the feedback loop from consequences / outcomes to causal conditions.

Central phenomenon.

In response to the causal conditions, DMS Global launched a multi-year project to implement an enterprise-wide commercial off-the-shelf PLM IS with the objective of automating engineering business processes in a manner that improved integration and productivity. This vision of success included a global integrated system with common processes and was reflected in the importance rating of PLM CSFs. For example, PLM CSF 08 Global Integrated System was not only ranked in top five for P1 Project Preparation, but also was the only PLM CSF that was not included in the consolidated lists of ERP CSFs from the academic literature. Similarly, PLM CSF 02 Business Process Reengineering (BPR) Common Processes was ranked second for P1 Project Preparation, and ranked first for P2 Blueprint. The final justification I offer in support of my claim that a global integrated system with common processes was the primary vision of success is the observance that there were no PLM CSFs with statistically significant difference from the ANOVA for P2 Blueprint. One focus group participant attributed the strong agreement on common processes to PLM CSF 18 Top Management Support when he observed, "From my vantage point, I think it is a combination of upper management direction of a general message of desired integration …" (FG, ID-22, p. 11).

The central phenomenon shapes, influences, and affects both contextual conditions and intervening conditions as indicated by the arrows from the central phenomenon to contextual and intervening conditions in Figure 16. For example, the professional culture mix would be different if the central phenomenon was the implementation of a human resources IS. Similarly, the global nature of the PLM IS implementation project created a national culture dynamic that would not be present in a project with a domestic focus. Likewise, the top management communication burden is typically greater in an international project than a site-specific initiative.

Contextual conditions.

Contextual conditions are narrow in scope, episodic in nature, and bound by time and place (Creswell, 2007, pp. 64–65; Strauss & Corbin, 1998, pp. 131–133). This definition led me to classify professional culture and phase-specific PLM CSFs as contextual conditions.

Despite a vision of success which desired an integrated global PLM IS, DMS Global adopted a segmented approach toward the implementation. Specifically, engineering was viewed as the customer of the PLM IS and IT as the supplier. The relationship is different than two equal partners striving towards a common goal. This customer / supplier paradigm places engineering in a more powerful position than IT. Hofstede et al (2010) called this dynamic *power-distance* and described it as the extent to which the less powerful members expect and accept the unequal distribution of power (p. 61). One in-depth interview participant hinted at the hidden, or subconscious, tension between engineering and IT when he stated, "I guess I'll just add a comment that I'm not sure how much, how closely that aligns with the stated goals of the project by [IT]" (DI, ID-17, p. 14). A similar sentiment was expressed by another in-depth interview participant:

> I get the impression that possibly my thoughts or priorities relative to this might be a little bit different than the some others…. I have some concerns that maybe they [IT consultants] are dropping back to the beginning … and losing focus a little bit … [IT] consultants need to maintain a focus that this is one PLM system for one company. I think that's a risk. (ID, ID-22, p. 16-17)

As the comments above indicate, there are rising tensions between engineers (customer) and IT (supplier). The customer / supplier relationship will likely be further aggravated not only by the 17 PLM CSFs with statistically significant differences in importance rating based on professional culture, but also by the bias of engineering to rate importance higher than IT. In short, the segmented customer / supplier view of PLM IS implementation may make conflict resolution problematic.

Different contexts give rise to different actions / interactions. As noted above, a context which frames the relationship between engineering and IT as customer / supplier will drive different actions and interactions than a relationship of equal partners. The link between contextual conditions and actions / interactions is captured by the arrow between these two elements in Figure 16.

Intervening conditions.

Intervening conditions are defined as broad in scope, constant in nature, and not bound by time and place (Creswell, 2007, pp. 64–65). Intervening conditions also "… mitigate or otherwise alter the impact of causal conditions on the phenomenon" Strauss & Corbin, 1998, p. 131). Given these definitions, I classified national culture and cross-phase CSFs as intervening conditions. The data also suggests PLM CSF 18 Top Management Support alters the actions / interactions related to the central phenomenon. One in-depth interview participant, when reflecting on top management communication observed:

> I have been pleasantly surprised with the heretofore openness on both the US and Japanese side to cooperate. I think there is a pretty good appreciation that we have an opportunity here, that if we miss it, it probably won't come along again in our careers here. And I think all the participants have attempted to optimize this opportunity. (DI, IT-03, p. 23)

The influence of intervening conditions on actions / interactions is portrayed in Figure 16 by the arrow from intervening conditions to actions / interactions.

Action / interaction.

Actions / interactions are defined as routine or strategic responses of groups and individuals to the phenomenon (Strauss & Corbin, 1998, p. 128). The actions / interactions are prompted by the mix of causal conditions associated with the central phenomenon, contextual conditions, and intervening conditions. These relationships are signified by the arrows leading into the actions / interactions element of Figure 16.

PLM CSFs represent both routine (tactical) and strategic actions / interactions. For example, phase-specific PLM CSFs such as 07 Data Migration, 17 Testing, and 19 Training represent tactical actions in response to project needs. Likewise, cross-phase PLM CSFs such as 13 Project Management, and 18 Top Management Support characterize strategic actions. Both routing and strategic CSFs are lead measures that are deterministic in nature and offer leverage to the project leadership.

The actions / interactions element of Figure 16 includes a bullet item for early intervention and root cause analysis. This bullet came from H-02 which claims early intervention improves PLM CSF outcomes. This is a response to a prior consequence / outcome that did not meet expectations. The unmet expectation acts a trigger, or causal condition, hence the feedback arrow from the consequences / outcomes element in Figure 16 to causal conditions.

Consequences / outcomes.

Consequences / outcomes are simply defined as the result of actions / interactions (Strauss & Corbin, 1998, p. 128). Therefore there is an arrow connecting these two elements in Figure 16. Given the central phenomenon was the implementation of a global PLM IS; the desired outcome would be attainment of the PLM goals and PLM vision of success.

As work progresses on the global PLM IS implementation, the project team is adding to their knowledge base of past experience. Significant past experiences (traumatic and non-traumatic) act as triggers that loop back to the top of the preliminary theoretical framework (Figure 16) and become causal conditions. Likewise, PLM CSFs with statistically significant differences in importance based on culture may also loop back to the top of the framework and cause a mix of causal, contextual and intervening conditions. For these reasons I included a feedback arrow from the bottom of the framework to the top of the framework, in essence making this a closed-loop model.

RQ5: preliminary theoretical framework discussion summary.

In summary, the data led to a preliminary theoretical framework integrating PLM IS implementation, culture, and CSFs. The framework represents an amalgamation of Rockart's (1979) CSF method and Strauss and Corbin's (1998) grounded theory axial coding paradigm.

The integrated theoretical framework is directed toward attainment of the vision of success. The flow begins with conditions which give rise to actions / interactions that produce consequences / outcome. Consequences / outcomes at the bottom of the model become an input to conditions as the top of the model forming a closed-loop. National culture and professional culture are incorporated in the framework as intervening and contextual conditions respectively. Likewise, phase-specific CSFs are assimilated as contextual conditions, and cross-phase CSFs as intervening CSFs. CSF 18 Top Management Support was added as an intervening condition based on its demonstrated ability to override national culture trends documented by Hofstede et al. (2010). Similarly, the codifying of the relationship between engineering and IT (professional cultures) by DMS Global as a customer / supplier association prompted me to include this as a contextual condition.

CSFs act as lead measures that predict the outcome of the goals and vision of success. CSFs are deterministic in nature and provide leverage to the project leadership team. By focusing management attention on a limited number of the most critical success factors, the project team maximized their influence on the outcome of the initiative. Without CSFs that determine the consequences / outcomes related to PLM goals and vision of success, the project leadership cannot be strategic; they have little recourse but to rely on brute force and sheer determination of will to move the project forward.

Limitations of the Study

While the study met its primary objectives, answered its research questions, and provided results that are applicable not only to other cases of global PLM IS implementations, but also to IS implementation in general, I would like to highlight two limitations.

First is the limited IS experience of the study participants. Of the 32 participants, 23 (71.88%) had no prior experience with global IS implementation. If the scope is narrowed to global PLM IS implementations, then 30 (93.75%) had no prior experience. Thus the majority of the DMS Global PLM project participants were novices with respect to global PLM IS implementation. Lack of experience certainly puts DMS Global at a disadvantage with respect to a global PLM IS implementation. Nevertheless, many organizations will find themselves in the same position. There is a first time for everything. Therefore this case study and its findings represent a reality many organizations will face. For organization with limited experience, an important CSF will be the evaluation and selection of competent and effective consultant / systems integrator to act as a trusted guide.

Second is scope of the research. Specifically, this was a bounded case study that concentrated on a single organization and two levels of culture: national (Japanese and US) and professional (engineering and IT).

In summary, the study was limited by the depth of participant experience and the breadth of the instrumental case.

Recommendations for Further Research

Replication of the study with experienced populations will add depth. Similarly, replication of the study in organizations with different cultural mixes will add breadth. Results of additional studies could be compared with the results of this study and the preliminary theoretical framework could be revised and strengthened.

Replication implies repeating the study using the same methods and protocols. Duplication of the study on a different population is a valid way forward because the results show Rockart's (1979) CSF method combined with Strauss and Corbin's (1998) grounded theory methods generate robust and useful results. Regardless, I recommend other methods be employed to study the phenomenon of global PLM IS implementation. For example, a Delphi study would offset the noted depth and breadth limitations while producing a balanced set of PLM CSFs.

My final recommendation for areas of further research is to design a study that explores the alignment of the strategic vision of success with tactical action on CSFs. Rockart's (1979) method assumes the vision of success drives and constrains goals, and the goals drive and constrain CSFs. The project team then focuses tactical execution on the CSFs, which meet goals, which in turn realizes the vision of success. The study would explore the nature of the alignment; how culture affects alignment; how culture affects execution; and the effectiveness of CSFs on attainment of the goals and the vision of success.

Chapter 5 Discussion Summary

This chapter discussed the results of the study. The discussion was organized by research question. All five research questions were answered and the discussion highlighted valuable insights for DMS Global, and for other organizations implementing a global PLM IS.

The purpose of this research was twofold. The primary purpose was to explore the challenges associated with global PLM IS implementations through the holistic analysis of the single instrumental DMS Global case (Creswell, 2007, p. 74, 75). The secondary aim was to develop a preliminary theoretical framework that modeled the process of implementing a global PLM IS in an engineer-to-order multi-cultural environment similar to DMS Global. This study accomplished both purposes.

A recurring theme in this study was to focus on the top five CSFs. In keeping with this theme, I conclude by offering a list of the top five most significant findings – plus one for good measure:

1. The differences between PLM CSFs and ERP CSFs are minimal. Accordingly, I recommend future research move away from generation of lists of CSFs towards application of the CSFs method in multi-cultural environments in a manner that realizes goals and the vision of success. Researchers are urged to use the list of PLM CSFs generated by this study, or one of the many lists of ERP CSFs available in the literature (Somers and Nelson, 2001; Soliman et al., 2011; Plant and Willcocks, 2007; Finney and Corbett, 2007; García-Sánchez and Pérez-Bernal, 2007; Frimpon 2011; Olszak and Ziemba, 2012).

2. The vision of success leads to goals which lead to CSFs. We should not, however, think of one monolithic list of CSFs for a global PLM IS implementation, but rather lists of CSFs where importance is determined by project phase. Nor should we think of one type of CSF. This study identified three types of CSFs which varied in their nature or essence: triggering causal CSFs; phase-specific contextual CSFs; and cross-phase intervening CSFs.
3. The rating of CSF importance by project phase on a Likert scale was a fruitful exercise. CSFs provide lead measures; they are predictive key performance indicators. They are deterministic in nature. Taking action on a CSFs influences consequences / outcomes which realize the goals and the vision of success. CSFs provide leverage as they allow project leadership to focus their efforts on the most critical items.
4. The ANOVA by culture identified CSFs with statistically significant differences in importance rating across both national and professional culture. The significant differences represent areas of potential conflict worthy of additional management care. Surprisingly, of the 22 PLM CSFs with statistically significant differences, the majority (17/22 or 77.27%) arose from professional culture and the minority (5/22 or 22.72%) from national culture. Particular attention should be given to CSFs with statistically significant differences ranked in the top five. Disagreement on a highly important CSF is more significant than disagreement on a CSF with low importance.
5. The emergence of a customer / supplier paradigm to model the relationship between engineers and IT associates working on the DMS Global PLM project placed engineering, as the customer defining system specifications, in a more powerful

position than IT, as the supplier working to meet specifications. This segregated view of IS implementation is radically different than two equal partners jointly striving towards a mutually agreed common goal and may lead to interactions that are formal, distant, at "arms-length." Further, IT associates may not be cognizant of, or willing to accept, this perspective.

6. The data supported development of a preliminary theoretical framework modeling the process of implementing a global PLM information system in an engineer-to-order multi-culture environment similar to DMS Global. The framework merged Rockart's (1979) CSF method with Strauss and Corbin's (1998) grounded theory axial coding paradigm producing an integrated closed-loop model applicable to a wide variety of IS implementation challenges.

In conclusion, the problem was the lack of a theoretical framework integrating global PLM IS implementations, culture, and CSFs. In response, the purpose of this research was to explore the challenges associated with global PLM IS implementations through the holistic analysis of the DMS Global case and to develop a preliminary theoretical framework that modeled the process of implementing a global PLM IS in an engineer-to-order multi-cultural environment similar to DMS Global. The dual purpose was refined by the identification of five research questions. To answer the research questions, this mixed-methods case study merged critical success factors (CSFs) with grounded theory and progressed through three stages of data collection and analysis; in-depth interviews, a quantitative survey, and a focus group.

This research met all of its objectives; answered its research questions; explored the challenges associated with global PLM IS implementations; developed a preliminary theoretical framework integrating PLM IS implementations, culture, and CSFs; filled a void in the academic literature; and yielded a practical mixed-methods approach to assess the vision of success, goals, and CSFs associated with multi-cultural global IS implementation. The results of this study are valuable not only to DMS Global but also to any organization faced with the complexity of implementing a global IS.

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Appendices

Appendix A: Robert Morris University IRB approval

ROBERT MORRIS UNIVERSITY

MEMORANDUM

TO: James F. Kimpel
318 Wheatley Center

FROM: Frederick G. Kohun, Ph.D.
Chair, Institutional Review Board
Robert Morris University

DATE: June 10, 2013

SUBJECT: IRB #130505–**A Global Product Lifecycle Management System Implementation Case Study: Towards a Conceptual Framework Integrating Global Product Lifecycle Management System Implementations, Critical Success Factors, and Cultures**

The above-referenced protocol has been approved through an expedited review procedure by the Institutional Review Board. This protocol meets all the necessary requirements and is hereby designated as exempt under section 45 CFR 46.101 (b)(2). Expedited protocols are approved for a period of three years. If you wish to continue the research after that time, a new application must be submitted.

Approval Date: June 10, 2013
Expiration Date: June 10, 2016

Please know that this IRB will be closed in the IRB database after 3 years.

cc: Dr. Ann Jabro

/lpn

Appendix B: DMS Global chief operating officer approval

To protect the confidentiality of DMS Global, the company letter head and full name of the Chief Operating Officer were redacted.

January 11, 2013

James F. Kimpel
[redacted]

Dear Jim,

The purpose of this letter is to confirm I am aware that you will be gathering data from [redacted] for your doctoral dissertation at Robert Morris University. I support your efforts and encourage participation as appropriate. [redacted] will make resources available to you as justified and practical.

Sincerely,


[redacted]

Chief Operating Officer

Appendix C: Consent form

ROBERT MORRIS UNIVERSITY

Robert Morris University Institutional Review Board
Approval Date: 06/10/2013
Renewal Date: 06/10/2015
IRB Number: 130505
Page: 1 of 2

CONSENT TO ACT AS A PARTICIPANT IN A RESEARCH STUDY

Title	A Global Product Lifecycle Management System Implementation Case Study
Principal Investigator	James F. Kimpel
Sources of Support	None

Consent Form

Description

The primary purpose of this research is to conduct a case study of the DMS Global Product Lifecycle Management (PLM) system implementation. The firm's privacy will be protected by using the alias "DMS Global" (representing design, manufacture, and service of heavy industry equipment on a global scale). A secondary aim of this research is to develop a conceptual framework that models the process of implementing a PLM system in an engineer-to-order multi-cultural environment similar to DMS Global if the data sufficiently leads to such development.

Data for this study will be collected in three stages. The first stage will be in-depth interviews (approximately 1.5 hours) with the PLM project steering committee. The second stage will be a survey of the PLM project team (approximately 0.75 hours). The third stage will be one focus group with the full steering committee (approximately 2.5 hours).

Risks and Benefits

There are no foreseeable risks associated with this project. The benefits likely to accrue include identification of critical success factors for the ongoing PLM system implementation, and a framework to guide future DMS Global integration efforts.

Voluntary Participation/Right to Withdraw

Your participation in this study is voluntary and independent from your job duties at DMS Global. You are free to refuse to participate in this study or withdraw at any time without penalty.

Initials: ______

Robert Morris University Institutional Review Board
Approval Date: 06/10/2013
Renewal Date: 06/10/2015
IRB Number: 130505
Page: 1 of 2

Confidentiality/Right to Privacy

Your privacy and confidentiality will be protected by assigning you a unique identification number. Data collected will be aggregated with other participants to create a composite picture. Electronic (soft copy) data will be stored in encrypted password protected files. Paper (hard copy) data will be stored in a locked file. Data collected will be used for the purpose of this research and will not be shared or sold to other researchers.

Cost and Payment

There is no cost for you to participate in this study. Similarly, there is no payment to you for participation in this study.

Compensation for Injury or Illness

In the unlikely event of physical injury or illness resulting from the research procedure, no momentary compensation will be made by Robert Morris University or the investigator. Robert Morris University and the investigator shall not be held liable.

Agreement to Participate

I have read this consent form. My current questions have been answered. I understand that I am encourage to ask questions about any aspect of this research during the course of this study and that such future questions will be answered by the researcher listed on the front page of this form.

Any questions which I have about my rights as a research participant will be answered by the Human Subjects Protection Advocate of the IRB Office, Robert Morris University (412.397.6227).

By signing this form, I agree to participate in this research study. A copy of this consent form will be given to me.

Signature	
Printed Name	
Date	

Appendix D: Purpose of the study

The purpose of this research is to conduct a case study of the DMS Global PLM system implementation and to develop a conceptual framework that models the process of implementing a PLM system in an engineer-to-order multi-cultural environment similar to DMS Global.

Appendix E: In-depth interview protocol

Introduction

Thank you for considering participation in this research study. Your privacy and confidentiality will be protected by assigning you a unique identification number. Data collected will be aggregated with other participants to create a composite picture. The firm's privacy will be secured by using the alias "DMS Global" (representing design, manufacture, and service of heavy industry equipment on a global scale). Electronic (soft copy) data will be stored in encrypted password protected files. Paper (hard copy) data will be stored in a locked file. Data collected will be used for the purpose of this research and will not be shared or sold to other researchers.

The primary purpose of this research is to conduct a case study of the DMS Global PLM system implementation. A secondary aim of this research is to develop a conceptual framework that models the process of implementing a PLM system in an engineer-to-order multi-cultural environment similar to DMS Global if the data sufficiently leads to such development.

To assure the accuracy of data collection, I would like to record our interview. Do I have your permission to record this interview?

- Yes
- No

Objectives

The objectives of this in-depth interview are to collect demographic data; to identify the PLM project vision of success; to document PLM system goals that break down the vision of success into specific targets to be attained; and to elicit CSFs that support the vision and goals. This interview will last approximately one and one half hours and will consist of the following eight sections:

1. First, an introduction which describes the purpose of the research.
2. Second, informed consent which confirms your willingness to participate in the study.
3. Third, gathering of demographic data about you.
4. Fourth, definition of “vision of success” and gathering your understanding of the PLM project vision of success.
5. Fifth, definition of the term “goals” and gathering your understanding of the PLM project goals.
6. Sixth, definition of “critical success factors” and gathering your understanding of the PLM project critical success factors.
7. Seventh, an open forum where you are encouraged to provide additional information you feel would be helpful to this research.
8. Eighth, and finally, is the conclusion.

To minimize the chance of bias, I will read the interview questions from this interview script. Feel free to ask questions should you need clarification. You are free to skip, or not answer, any question. Simply tell me you prefer not to provide an answer and I will move to the next question. You may also back up to a previous question if you have additional input that you would like to provide.

This concludes the first section of the interview, the introduction. Do you have any questions before we proceed?

[… record questions …]

Informed Consent

This second section of the interview documents your willingness to participate in the study. The invitation to this interview included a soft copy of the Consent Form. I am now handing you a paper copy of the Consent Form. If you have not yet had a chance to review the Consent Form, please do so now. [Wait for the participant to read the consent form …]

Do you have any questions regarding the Informed Consent Form?

[… record questions …]

Are you willing to sign the form?

- Yes.

  Thank you for signing the Consent From.

- No.

  I am sorry you were not able to sign the Consent From. This ends the interview.

  Thank you for your time and consideration.

Demographic Data

The third section of the interview gathers demographic data about you. There are ten demographic questions.

1. Please tell me the country in which you were born.
   - Country of birth.
   - I prefer not to provide an answer.
2. Please select the one most appropriate answer from the following list that best describes your current age.
   - Under 25 years of age.
   - 26 to 30 years of age.
   - 31 to 35 years of age.
   - 36 to 40 years of age.
   - 41 to 45 years of age.
   - 46 to 50 years of age.
   - 51 years or more of age.
   - I prefer not to provide an answer.

3. Please select the one most appropriate answer from the following list that best describes your highest level of education.

   - High School.
   - Associates Degree form a College, University, or Technical School.
   - Bachelor Degree from a College or University.
   - Master Degree from a College or University.
   - Doctoral Degree from a College or University.
   - Other, please specify.
   - I prefer not to provide an answer.

4. [This question will be skipped if the participant's highest level of education is high school]. Please describe your major, or area of study, for your higher education. If you have more than one major, or area of study, then please describe them all.

   - I prefer not to provide an answer.

5. Please select the one most appropriate answer from the following list that best describes your total number of years of work experience.
   - Less than 1 year.
   - 2 to 5 years.
   - 6 to 10 years.
   - 11 to 15 years.
   - 16 to 20 years.
   - 21 to 25 years.
   - 26 to 30 years.
   - 31 years or more.
   - I prefer not to provide an answer.
6. Please tell me your current job title in DMS Global.
   - DMS Global job title.

   - I prefer not to provide an answer.

7. Please select the one most appropriate answer from the following list that best describes the number of years you have worked for DMS Global.
   - Less than 1 year.
   - 2 to 5 years.
   - 6 to 10 years.
   - 11 to 15 years.
   - 16 to 20 years.
   - 21 to 25 years.
   - 26 to 30 years.
   - 31 years or more.
   - I prefer not to provide an answer.

8. Please select the one most appropriate answer from the following list that best describes the total amount of time you have been involved in the DMS Global PLM project.
   - Less than 3 months.
   - More than 3 months and less than 6 months.
   - More than 6 months and less than 9 months.
   - More than 9 months and less than 12 months.
   - More than 12 months and less than 15 months.
   - More than 15 months and less than 18 months.
   - More than 18 months and less than 21 months.
   - More than 21 months to less than 24 months.
   - More than 24 months.
   - I prefer not to provide an answer.

9. Please select the one most appropriate answer from the following list that describes the current phase of your PLM project.
   - ○ 1. Project Preparation Phase: Identify the information system vision of success and goals. Define the project scope, schedule, resources, cost, and risk.
   - ○ 2. Blueprint Phase: Design the business architecture (organizational and process design). Design the supporting information technology architecture (software, database, and infrastructure design).
   - ○ 3. Realization Phase: Build, test, and document the information system.
   - ○ 4. Final Preparation: Train end users and migrate legacy data.
   - ○ 5. Go Live & Support Phase: Activate the information system and stabilize operations.
   - ○ I prefer not to provide an answer.

10. If you have been involved in past information system implementation projects, then please briefly describe the projects and your role.
    - ○ Yes. Please briefly describe your past experience.
    - ○ No.
    - ○ I prefer not to provide an answer.

PLM Project Vision of Success

The fourth section of the interview defines "vision of success" and gathers your understanding of the PLM project vision of success. "Vision of success" is defined as: general statements about what the PLM system will do for DMS Global when implemented.

Given this definition, please briefly describe your understanding the PLM project vision of success.

- [Participant description of the PLM project vision of success…]

  [… When the participant stops …]

- Thank you; do you have any additional thoughts regarding the vision of PLM project success?

- I prefer not to provide an answer.

PLM Project Goals

The fifth section of the interview defines the term "goals" and gathers your understanding of the PLM project goals. "Goals" are defined as: specific targets to be met in a period of time to realize the PLM project vision of success.

Given this definition, please briefly describe your understanding the PLM project goals.

- [Participant description of the PLM project goals…]

[… When the participant stops …]

- Thank you; do you have any additional thoughts regarding the PLM project goals?

- I prefer not to provide an answer.

PLM Project Critical Success Factors

The sixth section of the interview defines "critical success factors" and gathers your understanding of the PLM project critical success factors. "Critical success factors" are defined as: the limited number of areas where things must go right in order to achieve the PLM project goals and vision of success.

- Will you please tell me, in whatever order they come to mind, those things that you see as critical success factors for the DMS Global PLM project.

- Let me ask the same questions concerning critical success factors in another way. In what one, two, or three areas would failure to perform well hurt the PLM project? In short, where would you most hate to see something go wrong in the PLM project?

- Thank you; do you have any additional thoughts regarding PLM project critical success factors?

- I prefer not to provide an answer.

Open Forum

The seventh section of the interview is an open forum where you are encouraged to provide additional information you feel would be helpful to this research.

- Do you have any additional information you feel would be helpful to this research?

- I prefer not to provide an answer.

Conclusion

This concludes our interview. Do you have any additional questions, concerns, or information you feel I should know?

- Additional questions.

- Additional concerns.

- Information you feel I should know.

- I prefer not to provide an answer.

This concludes our interview. Do you have any additional questions, concerns, or information you feel I should know?

- Additional questions.

- Additional concerns.

- Information you feel I should know.

- I prefer not to provide an answer.

The next steps in this research are to:

1. Complete the interviews of the DMS Global PLM project steering committee members.
2. Analyze the result of the DMS Global PLM project steering committee member interviews.
3. Survey the DMS Global PLM project team members.
4. Analyze the results of the DMS Global PLM project team member survey.
5. Develop the conceptual framework to guide global PLM system implementations.
6. Conduct two focus groups with the DMS Global PLM project steering committee. Steering committee members may attend one of the two focus groups that best suits their schedule. The objectives of the focus groups are: to share the results of the data collection and analysis; to present the conceptual framework; and to critique the conceptual framework.

Thank you for giving you valuable time to this research project.

Appendix F: Survey protocol

This appendix presents the survey protocol in two formats. First is a text only version of the protocol. Second is the survey as presented in QuestionPro. Below is the text only version.

1.0 Introduction

Purpose of the study.

The purpose of this research is to conduct a case study of the DMS Global Product Lifecycle Management (PLM) system implementation and to develop a conceptual framework that models the process of implementing a PLM system in an engineer-to-order multi-cultural environment similar to DMS Global.

Organization

This survey gathers data from the PLM project core and extended teams and is organized in eight sections as follows:

1. Introduction (this section).
2. Demographic Data.
3. PLM Project Vision of Success.
4. PLM Project Goals.
5. Critical Success Factor Importance by Project Phase.
6. DMS Global Openness to New Ideas
7. Open Forum.
8. Conclusion.

Each section begins on a new page

Confidentiality/right to privacy.

Your privacy and confidentiality will be protected by assigning you a unique identification number. Data collected will be aggregated with other participants to create a composite picture.

Survey completion.

The survey will require between 30 and 45 minutes of your time.

If you need to save a partially completed survey and return at a later time to finish, answer all the questions on the current web page and then click the "Save Page and Continue Later" button. You will be prompted to enter your email address. The web site will send you an email with a link to continue the survey.

To submit your completed survey, click on the "Finish and Save Survey" button on the final page of the survey.

2.0 Demographics

The second section of the interview gathers demographic data about you. There are ten demographic questions.

2.1 Please tell me the country in which you were born in the space below.

2.2 Please select the one most appropriate answer from the following list that best describes your gender.

- Male.
- Female.
- I prefer not to provide a response.

2.3 Please select the one most appropriate answer from the following list that best describes your current age.

- Under 25 years of age.
- 26 to 30 years of age.
- 30 to 35 years of age.
- 36 to 40 years of age.
- 41 to 45 years of age.
- 46 to 50 years of age.
- 51 years or more of age.
- I prefer not to provide a response.

2.4 Please select the one most appropriate answer from the following list that best describes your highest level of education.

- High School.
- Associates Degree from a College, University, or Technical School.
- Bachelor Degree from a College or University.
- Master Degree from a College or University.
- Doctoral Degree from a College or University.
- I prefer not to provide a response.
- Other. ______________________

2.5 Please select the one most appropriate answer from the following list that best describes your total years of work experience.

- Less than 1 year.
- 2 to 5 years.
- 6 to 10 years.
- 11 to 15 years.
- 16 to 20 years.
- 21 to 25 years.
- 26 to 30 years.
- 31 years or more.
- I prefer not to provide a response.

2.6 Please provide your current job title with DMS Global in the space below.

2.7 Please select the one most appropriate answer from the following list that best describes the number of years you have worked for DMS Global.

- Less than 1 year.
- 2 to 5 years.
- 6 to 10 years.
- 11 to 15 years.
- 16 to 20 years.
- 21 to 25 years.
- 26 to 30 years.
- 31 years or more.
- I prefer not to provide a response.

2.8 Please select the one most appropriate answer from the following list that best describes the total amount of time you have been involved with the DMS Global PLM project.

- Less than 3 months.
- More than 3 months to 6 months.
- More than 6 months to 9 months.
- More than 9 months to 12 months.
- More than 12 months to 15 months.
- More than 15 months to 18 months.
- More than 18 months to 21 months.
- More than 21 months to 24 months.
- More than 24 months.
- I prefer not to provide a response.

2.9 Please select the one most appropriate answer from the following list that describes the current phase of your PLM project.

- Project Preparation Phase: Identify the information system vision of success and goals. Define the project scope, schedule, resources, cost, and risk.
- Blueprint Phase: Design the business architecture (organization and process design). Design the supporting information technology architecture (software, database, and infrastructure design).
- Realization Phase: Build, test, and document the information system.
- Final Preparation Phase: Train end users and migrate legacy data.
- Go Live & Support Phase: Activate the information system and stabilize operations.
- I do not know the current phase of my PLM project.
- I prefer not to provide a response.

2.10 If you have past global system implementation experience, then please briefly describe your past experience in the space below.

3.0 PLM Project Vision of Success

The third section of the survey gathers your understanding of the PLM project "vision of success."

"Vision of success" is defined as: general statements about what the PLM system will do for DMS Global when implemented.

3.1 Given this definition, please briefly describe your understanding of the PLM project vision of success in the space below. If you prefer not to provide a response, simply type, "I prefer not to provide a response."

4.0 PLM Project Goals

The fourth section of the survey gathers your understanding of the PLM project "goals." "Goals" are defined as: specific targets to be met in a period of time to realize the PLM project vision of success.

4.1 Given this definition, please briefly describe your understanding of the PLM project goals in the space below. Please number your goals 1, 2, 3, etc. If you prefer not to provide a response, simply type, "I prefer not to provide a response."

5.0 PLM Critical Success Factor Importance by Project Phase

The fifth section of the survey asks you to rate the importance of critical success factors for each of the following five PLM project phases.

1. Project Preparation Phase: Identify the information system vision of success and goals. Define the project scope, schedule, resources, cost, and risk.
2. Blueprint Phase: Design the business architecture (organization and process design). Design the supporting information technology architecture (software, database, and infrastructure design).
3. Realization Phase: Build, test, and document the information system.
4. Final Preparation Phase: Train end users and migrate legacy data.
5. Go Live & Support Phase: Activate the information system and stabilize operations.

   "Critical success factors" are defined as: the limited number of areas where things must go right in order to achieve the PLM project goals and vision of success.

The following five subsections will progress through each of the five PLM project phases. For each project phase, an identical set of critical success factors will be presented in alphabetical order. The critical success factors are a result of interviews with the DMS Global PLM project steering committee, and a review of the academic literature. Beside each critical success factor will be a rating scale ranging from 1 (Not Important) to 7 (Critically Important) that will allow you to rate the importance of the critical success factor for the PLM project phase. If you are unable to judge the importance of the critical success factor for the PLM project phase then please choose the rating of N/A (Not Applicable).

You will also be given the opportunity to add critical success factors for each project phase that you feel were missing from the standard list.

5.1 Project Preparation Phase critical success factors.

Please rate the importance of each of the following critical success factors for the …
Project Preparation Phase: Identify the information system vision of success and goals. Define the project scope, schedule, resources, cost, and risk.

1. Business Case: Develop a business case that identifies how the PLM system will provide value through effective, efficient processes that increase revenue, profit, and productivity while allowing for continuous improvement.
2. Business Process Reengineering (Common Processes): Reengineer DMS Global processes to utilize common PLM system best practices. Minimize complexity and software customization.
3. Change Management: Develop a comprehensive, culturally sensitive, change management plan that facilitates the implementation of the PLM system.
4. Consultant (System Integrator): Identify, evaluate, and select a PLM consulting firm that is not only technically competent, but also understands the DMS Global business and is willing to work collaboratively.

5. Budget (Cost): Identify the project costs, allocate the necessary funds, and monitor spending against budget.
6. Customer Satisfaction: Collaborate with customers to understand their requirements, and then implement a PLM system that will satisfy their needs.
7. Data Conversion: Analyze data to assure an accurate and complete migration of data from legacy systems to the PLM system
8. Global Integrated System: Implement the PLM system in a manner that provides one global engineering system that can be used by all DMS Global locations and business units (Engineered Products, Industrial Products, and Global Service). Make certain the PLM system is integrated with Enterprise Resource Planning (ERP) systems and Microsoft Excel.
9. Goals and Objectives (Scope): Identify a prioritized and limited list of clearly defined measurable goals and objectives for the PLM system.
10. Implementation Strategy: Establish an implementation strategy that deploys the PLM system in a phased approach.
11. Past Experience (Lessons Learned): Review past experience with PLM system implementation and apply lessons learned.
12. PLM System Evaluation and Selection: Identify, evaluate, and select the PLM system that not only meets short-term information and process needs, but also provides a foundation for long-term global growth.
13. Project Management: Provide for the ongoing management (planning, monitoring, and controlling) of the scope, schedule, resources, cost, and risk of the PLM system implementation.

14. Project Team (Resources): Assemble a team of technically competent individuals who understand the engineering needs of DMS Global and who are willing to work on the PLM system implementation. Give the team adequate time to work on the project.
15. Risk Management (Quality Assurance): Identify and assess risks. Establish a risk management plan that assures the quality of the PLM system implementation.
16. Timeline (Schedule): Create a realistic implementation timeline, monitor progress, and adjust as necessary.
17. Testing: Create and execute a system test plan, including simulated real-world test cases, that validates the PLM system meets expectations.
18. Top Management Support: Assemble a global team of top managers (steering committee) who are committed to the successful implementation of the PLM system. The team establishes goals and objectives, monitors progress, allocates human and financial resources, and resolves conflicts.
19. Training: Provide initial (short-term) and ongoing (long-term) high-quality training so that users know how to do their jobs in the PLM system. Support the training with good documentation and manuals.
20. User Satisfaction: Collaborate with users to understand their requirements, and then implement a PLM system that will satisfy their needs.

- No Importance
- Very Low Importance
- Low Importance
- Moderate Importance
- High Importance
- Very High Importance
- Critical Importance
- N/A

In the space below, please add critical success factors for the Project Preparation Phase that you feel were missing from the preceding standard list.

Please number each critical success factor you add; provide a description of the critical success factor; and indicate the importance rating (from 1 to 7). For example:

1. First additional critical success factor description. Importance Rating = 4.
2. Second additional critical success factor description. Importance Rating = 7.

5.2 Blueprint Phase critical success factors.

Please rate the importance of each of the following critical success factors for the …

Blueprint Phase: Design the business architecture (organization and process design). Design the supporting information technology architecture (software, database, and infrastructure design)

Display the 21 Critical Success Factors with 1 to 7 Likert scale from question 5.1.

In the space below, please add critical success factors for the Blueprint Phase that you feel were missing from the preceding standard list.

Please number each critical success factor you add; provide a description of the critical success factor; and indicate the importance rating (from 1 to 7). For example:

1. First additional critical success factor description. Importance Rating = 4.
2. Second additional critical success factor description. Importance Rating = 7.

5.3 Realization Phase critical success factors.

Please rate the importance of each of the following critical success factors for the …

Realization Phase: Build, test, and document the information system.

Display the 21 Critical Success Factors with 1 to 7 Likert scale from question 5.1.

In the space below, please add critical success factors for the Realization Phase that you feel were missing from the preceding standard list.

Please number each critical success factor you add; provide a description of the critical success factor; and indicate the importance rating (from 1 to 7). For example:

1. First additional critical success factor description. Importance Rating = 4.
2. Second additional critical success factor description. Importance Rating = 7.

5.4 Final Preparation Phase critical success factors.

Please rate the importance of each of the following critical success factors for the …

Final Preparation Phase: Train end users and migrate legacy data.

Display the 21 Critical Success Factors with 1 to 7 Likert scale from question 5.1.

In the space below, please add critical success factors for the Final Preparation Phase that you feel were missing from the preceding standard list.

Please number each critical success factor you add; provide a description of the critical success factor; and indicate the importance rating (from 1 to 7). For example:

1. First additional critical success factor description. Importance Rating = 4.
2. Second additional critical success factor description. Importance Rating = 7.

5.5 Go Live & Support Phase critical success factors.

Please rate the importance of each of the following critical success factors for the …

Go Live & Support Phase: Activate the information system and stabilize operations.

Display the 21 Critical Success Factors with 1 to 7 Likert scale from question 5.1.

In the space below, please add critical success factors for the Go Live & Support Phase that you feel were missing from the preceding standard list.

Please number each critical success factor you add; provide a description of the critical success factor; and indicate the importance rating (from 1 to 7). For example:

1. First additional critical success factor description. Importance Rating = 4.
2. Second additional critical success factor description. Importance Rating = 7.

6.0 DMS Global Openness to New Ideas

The sixth section of the survey asks you to rate your agreement with the following five statements regarding DMS Global's openness to new ideas.

Beside each statement will be a rating scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree) that will allow you to record your level of agreement. If you are unable to judge your level of agreement then please choose the rating of N/A (Not Applicable).

6.1 Technical innovation, based on research results, is readily accepted.

6.2 Management actively seeks innovative ideas.

6.3 Innovation is readily accepted in program/project management.

6.4 People are penalized for new ideas that don't work.

6.5 Innovation in DMS Global is perceived as too risky and is resisted.

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

7.0 Open Forum

This seventh section of the survey is an open forum.

7.1 Please provide additional information you feel would be helpful to this research in the space below.

8.0 Conclusion

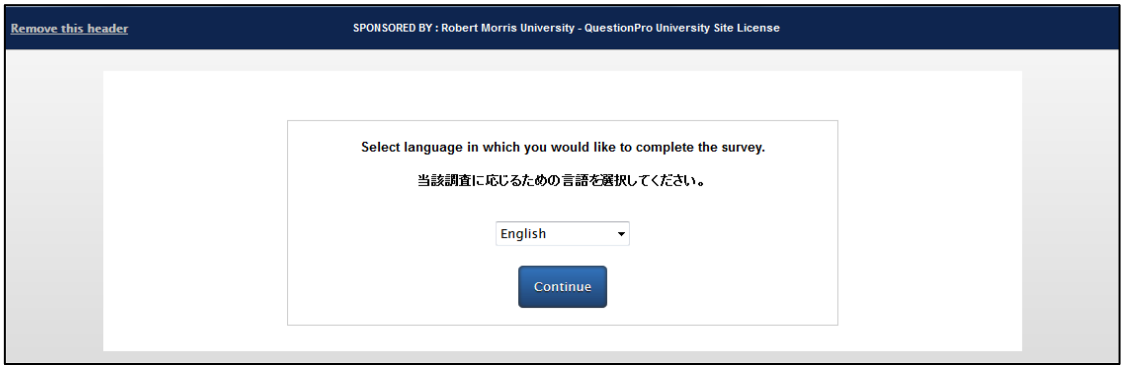
This eighth section completes the survey.

8.1 Do you have any additional questions, concerns, or information you feel the researcher should know? Please provide your response in the space below.

The next steps in this research are to: analyze the results of the DMS Global PLM project team member survey; develop the conceptual framework to guide global PLM system implementations; and conduct a focus group with the DMS Global PLM project steering committee. The objectives of the focus group are: to share the results of the data collection and analysis; to present the conceptual framework; and to critique the conceptual framework.

Thank you for giving your valuable time to this research project. The survey is now complete. Please click the "Finish and Save Survey" button to finalize and submit your survey response.

Below is the survey as presented online in QuestionPro.



Survey: DISC02

PLM Project Survey

1.0 Introduction

Purpose of the study.

The purpose of this research is to conduct a case study of the DMS Global Product Lifecycle Management (PLM) system implementation and to develop a conceptual framework that models the process of implementing a PLM system in an engineer-to-order multi-cultural environment similar to DMS Global.

Organization.

This survey gathers data from the PLM project core and extended teams and is organized in eight sections as follows:

1. Introduction (this section).
2. Demographic Data.
3. PLM Project Vision of Success.
4. PLM Project Goals.
5. Critical Success Factor Importance by Project Phase.
6. DMS Global Openness to New Ideas
7. Open Forum.
8. Conclusion.

Each section begins on a new page.

Confidentiality/right to privacy.

Your privacy and confidentiality will be protected by assigning you a unique identification number. Data collected will be aggregated with other participants to create a composite picture.

Survey completion.

The survey will require between 30 and 45 minutes of your time.

If you need to save a partially completed survey and return at a later time to finish, answer all the questions on the current web page and then click the "Save Page and Continue Later" button. You will be prompted to enter your email address. The web site will send you an email with a link to continue the survey.

To submit your completed survey, click on the "Finish and Save Survey" button on the final page of the survey.

2.0 Demographics

The second section of the interview gathers demographic data about you. There are ten demographic questions.

2.1 Please tell me the country in which you were born in the space below.

2.2 Please select the one most appropriate answer from the following list that best describes your gender.

- Male.
- Female.
- I prefer not to provide a response.

2.3 Please select the one most appropriate answer from the following list that best describes your current age.

- Under 25 years of age.
- 26 to 30 years of age.
- 30 to 35 years of age.
- 36 to 40 years of age.
- 41 to 45 years of age.
- 46 to 50 years of age.
- 51 years or more of age.
- I prefer not to provide a response.

2.4 Please select the one most appropriate answer from the following list that best describes your highest level of education.

- High School.
- Associates Degree from a College, University, or Technical School.
- Bachelor Degree from a College or University.
- Master Degree from a College or University.
- Doctoral Degree from a College or University.
- I prefer not to provide a response.
- Other

2.5 Please select the one most appropriate answer from the following list that best describes your total years of work experience.

- Less than 1 year.
- 2 to 5 years.
- 6 to 10 years.
- 11 to 15 years.
- 16 to 20 years.
- 21 to 25 years.
- 26 to 30 years.
- 31 years or more.
- I prefer not to provide a response.

2.6 Please provide your current job title with the DMS Global in the space below.

2.7 Please select the one most appropriate answer from the following list that best describes the number of years you

This screen shot demonstrates the Japanese language version of the first three demographic questions.

have worked for DMS Global.

- Less than 1 year.
- 2 to 5 years.
- 6 to 10 years.
- 11 to 15 years.
- 16 to 20 years.
- 21 to 25 years.
- 26 to 30 years.
- 31 years or more.
- I prefer not to provide a response.

2.8 Please select the one most appropriate answer from the following list that best describes the total amount of time you have been involved with the DMS Global PLM project.

- Less than 3 months.
- More than 3 months to 6 months.
- More than 6 months to 9 months.
- More than 9 months to 12 months.
- More than 12 months to 15 months.
- More than 15 months to 18 months.
- More than 18 months to 21 months.
- More than 21 months to 24 months.
- More than 24 months.
- I prefer not to provide a response.

2.9 Please select the one most appropriate answer from the following list that describes the current phase of your PLM project.

- Project Preparation Phase: Identify the information system vision of success and goals. Define the project scope, schedule, resources, cost, and risk.
- Blueprint Phase: Design the business architecture (organization and process design). Design the supporting information technology architecture (software, database, and infrastructure design).
- Realization Phase: Build, test, and document the information system.
- Final Preparation Phase: Train end users and migrate legacy data.
- Go Live & Support Phase: Activate the information system and stabilize operations.
- I do not know the current phase of my PLM project.
- I prefer not to provide a response.

2.10 If you have past global system implementation experience, then please briefly describe your past experience in the space below.

3.0 PLM Project Vision of Success

The third section of the survey gathers your understanding of the PLM project "vision of success."

"Vision of success" is defined as: general statements about what the PLM system will do for DMS Global when implemented.

3.1 Given this definition, please briefly describe your understanding of the PLM project vision of success in the space below. If you prefer not to provide a response, simply type, "I prefer not to provide a response."

4.0 PLM Project Goals

The fourth section of the survey gathers your understanding of the PLM project "goals."

"Goals" are defined as: specific targets to be met in period of time to realize the PLM project vision of success.

4.1 Given this definition, please briefly describe your understanding of the PLM project goals in the space below. Please number your goals 1, 2, 3, etc. If you prefer not to provide a response, simply type, "I prefer not to provide a response."

5.0 PLM Critical Success Factor Importance by Project Phase

The fifth section of the survey asks you to rate the importance of critical success factors for each of the following five PLM project phases.

1. Project Preparation Phase: Identify the information system vision of success and goals. Define the project scope, schedule, resources, cost, and risk.
2. Blueprint Phase: Design the business architecture (organization and process design). Design the supporting information technology architecture (software, database, and infrastructure design).
3. Realization Phase: Build, test, and document the information system.
4. Final Preparation Phase: Train end users and migrate legacy data.

5. Go Live & Support Phase: Activate the information system and stabilize operations.

"Critical success factors" are defined as: the limited number of areas where things must go right in order to achieve the PLM project goals and vision of success.

The following five sub-sections will progress through each of the five PLM project phases. For each project phase, an identical set of critical success factors will be presented in alphabetical order. The critical success factors are a result of interviews with the DM Global PLM project steering committee, and a review of the academic literature. Beside each critical success factor will be a rating scale ranging from 1 (Not Important) to 7 (Critically Important) that will allow you to rate the importance of the critical success factor for the PLM project phase. If you are unable to judge the importance of the critical success factor for the PLM project phase then please choose the rating of N/A (Not Applicable).

You will also be given the opportunity to add critical success factors for each project phase that you feel were missing from the standard list.

5.1 Project Preparation Phase critical success factors.

Please rank the importance of each of the following critical success factors for the ...
Project Preparation Phase: Identify the information system vision of success and goals. Define the project scope, schedule, resources, cost, and risk.

	No Importance	Very Low Importance	Low Importance	Moderate Importance	High Importance	Very High Importance	Critical Importance	N/A
1. Business Case: Develop a business case that identifies how the PLM system will provide value through effective, efficient processes that increase revenue, profit, and productivity while allowing for continuous improvement.	○	○	○	○	○	○	○	○
2. Business Process Reengineering (Common Processes): Reengineer DMS Global processes to utilize common PLM system best practices. Minimize complexity and software customization.	○	○	○	○	○	○	○	○
3. Change Management: Develop a comprehensive, culturally sensitive, change management plan that facilitates the implementation of the PLM system.	○	○	○	○	○	○	○	○
4. Consultant (System Integrator): Identify, evaluate, and select a PLM consulting firm that is not only technically competent, but also understands the DMS Global business and is willing to work collaboratively.	○	○	○	○	○	○	○	○
5. Budget (Cost): Identify the project costs, allocate the necessary funds, and monitor spending against budget.	○	○	○	○	○	○	○	○
6. Customer Satisfaction: Collaborate with customers to understand their requirements, and then implement a PLM system that will satisfy their needs.	○	○	○	○	○	○	○	○
7. Data Conversion: Analyze data to assure an accurate and complete migration of data from legacy systems to the PLM system	○	○	○	○	○	○	○	○
8. Global Integrated System: Implement the PLM system in a manner that provides one global engineering system that can be used by all DMS Global locations and business units. Make certain the PLM system is integrated with Enterprise Resource Planning (ERP) systems and	○	○	○	○	○	○	○	○

Microsoft Excel.								
9. Goals and Objectives (Scope): Identify a prioritized and limited list of clearly defined measurable goals and objectives for the PLM system.	○	○	○	○	○	○	○	○
10. Implementation Strategy: Establish an implementation strategy that deploys the PLM system in a phased approach.	○	○	○	○	○	○	○	○
11. Past Experience (Lessons Learned): Review past experience with PLM system implementation and apply lessons learned.	○	○	○	○	○	○	○	○
12. PLM System Evaluation and Selection: Identify, evaluate, and select the PLM system that not only meets short-term information and process needs, but also provides a foundation for long-term global growth.	○	○	○	○	○	○	○	○
13. Project Management: Provide for the ongoing management (planning, monitoring, and controlling) of the scope, schedule, resources, cost, and risk of the PLM system implementation.	○	○	○	○	○	○	○	○
14. Project Team (Resources): Assemble a team of technically competent individuals who understand the engineering needs of DMS Global and who are willing to work on the PLM system implementation. Give the team adequate time to work on the project.	○	○	○	○	○	○	○	○
15. Risk Management (Quality Assurance): Identify and assess risks. Establish a risk management plan that assures the quality of the PLM system implementation.	○	○	○	○	○	○	○	○
16. Timeline (Schedule): Create a realistic implementation timeline, monitor progress, and adjust as necessary.	○	○	○	○	○	○	○	○
17. Testing: Create and execute a system test plan, including simulated real-world test cases, that validates the PLM system meets expectations.	○	○	○	○	○	○	○	○
18. Top Management Support: Assemble a global team of top managers (steering committee) who are committed to the successful implementation of the PLM system. The team establishes goals and objectives, monitors progress, allocates human and financial resources, and resolves conflicts.	○	○	○	○	○	○	○	○
19. Training: Provide initial (short-term) and ongoing (long-term) high-quality training so that users know how to do their jobs in the PLM system. Support the training with good documentation and manuals.	○	○	○	○	○	○	○	○
20. User Satisfaction: Collaborate with users to understand their requirements, and then implement a PLM system that will satisfy their needs.	○	○	○	○	○	○	○	○

In the space below, please add critical success factors for the Project Preparation Phase that you feel were missing from the preceding standard list.

Please number each critical success factor you add; provide a description of the critical success factor; and indicate the importance rating (from 1 to 7). For example:

1. First additional critical success factor description. Importance Rating = 4.
2. Second additional critical success factor description. Importance Rating = 7.

5.2 Blueprint Phase critical success factors.

Please rank the importance of each of the following critical success factors for the ...
Blueprint Phase: Design the business architecture (organization and process design). Design the supporting information technology architecture (software, database, and infrastructure design)

	No Importance	Very Low Importance	Low Importance	Moderate Importance	High Importance	Very High Importance	Critical Importance	N/A
1. Business Case: Develop a business case that identifies how the PLM system will provide value through effective, efficient processes that increase revenue, profit, and productivity while allowing for continuous improvement.	○	○	○	○	○	○	○	○
2. Business Process Reengineering (Common Processes): Reengineer DMS Global processes to utilize common PLM system best practices. Minimize complexity and software customization.	○	○	○	○	○	○	○	○
3. Change Management: Develop a comprehensive, culturally sensitive, change management plan that facilitates the implementation of the PLM system.	○	○	○	○	○	○	○	○
4. Consultant (System Integrator): Identify, evaluate, and select a PLM consulting firm that is not only technically competent, but also understands the DMS Global business and is willing to work collaboratively.	○	○	○	○	○	○	○	○
5. Budget (Cost): Identify the project costs, allocate the necessary funds, and monitor spending against budget.	○	○	○	○	○	○	○	○
6. Customer Satisfaction: Collaborate with customers to understand their requirements, and then implement a PLM system that will satisfy their needs.	○	○	○	○	○	○	○	○
7. Data Conversion: Analyze data to assure an accurate and complete migration of data from legacy systems to the PLM system	○	○	○	○	○	○	○	○

8. Global Integrated System: Implement the PLM system in a manner that provides one global engineering system that can be used by all DMS Global locations and business units. Make certain the PLM system is integrated with Enterprise Resource Planning (ERP) systems and Microsoft Excel.	○	○	○	○	○	○	○	○
9. Goals and Objectives (Scope): Identify a prioritized and limited list of clearly defined measurable goals and objectives for the PLM system.	○	○	○	○	○	○	○	○
10. Implementation Strategy: Establish an implementation strategy that deploys the PLM system in a phased approach.	○	○	○	○	○	○	○	○
11. Past Experience (Lessons Learned): Review past experience with PLM system implementation and apply lessons learned.	○	○	○	○	○	○	○	○
12. PLM System Evaluation and Selection: Identify, evaluate, and select the PLM system that not only meets short-term information and process needs, but also provides a foundation for long-term global growth.	○	○	○	○	○	○	○	○
13. Project Management: Provide for the ongoing management (planning, monitoring, and controlling) of the scope, schedule, resources, cost, and risk of the PLM system implementation.	○	○	○	○	○	○	○	○
14. Project Team (Resources): Assemble a team of technically competent individuals who understand the engineering needs of DMS Global and who are willing to work on the PLM system implementation. Give the team adequate time to work on the project.	○	○	○	○	○	○	○	○
15. Risk Management (Quality Assurance): Identify and assess risks. Establish a risk management plan that assures the quality of the PLM system implementation.	○	○	○	○	○	○	○	○
16. Timeline (Schedule): Create a realistic implementation timeline, monitor progress, and adjust as necessary.	○	○	○	○	○	○	○	○
17. Testing: Create and execute a system test plan, including simulated real-world test cases, that validates the PLM system meets expectations.	○	○	○	○	○	○	○	○
18. Top Management Support: Assemble a global team of top managers (steering committee) who are committed to the successful implementation of the PLM system. The team establishes goals and objectives, monitors progress, allocates human and financial resources, and resolves conflicts.	○	○	○	○	○	○	○	○
19. Training: Provide initial (short-term) and ongoing (long-term) high-quality training so that users know how to do their jobs in the PLM system. Support the training with good documentation and manuals.	○	○	○	○	○	○	○	○

20. User Satisfaction: Collaborate with users to understand their requirements, and then implement a PLM system that will satisfy their needs.	○	○	○	○	○	○	○	○

In the space below, please add critical success factors for the Blueprint Phase that you feel were missing from the preceding standard list.

Please number each critical success factor you add; provide a description of the critical success factor; and indicate the importance rating (from 1 to 7). For example:

1. First additional critical success factor description. Importance Rating = 4.
2. Second additional critical success factor description. Importance Rating = 7.

5.3 Realization Phase critical success factors.

Please rank the importance of each of the following critical success factors for the ...
Realization Phase: Build, test, and document the information system.

	No Importance	Very Low Importance	Low Importance	Moderate Importance	High Importance	Very High Importance	Critical Importance	N/A
1. Business Case: Develop a business case that identifies how the PLM system will provide value through effective, efficient processes that increase revenue, profit, and productivity while allowing for continuous improvement.	○	○	○	○	○	○	○	○
2. Business Process Reengineering (Common Processes): Reengineer DMS Global processes to utilize common PLM system best practices. Minimize complexity and software customization.	○	○	○	○	○	○	○	○
3. Change Management: Develop a comprehensive, culturally sensitive, change management plan that facilitates the implementation of the PLM system.	○	○	○	○	○	○	○	○
4. Consultant (System Integrator): Identify, evaluate, and select a PLM consulting firm that is not only technically competent, but also understands the DMS Global business and is willing to work collaboratively.	○	○	○	○	○	○	○	○
5. Budget (Cost): Identify the project costs, allocate the necessary funds, and monitor spending against budget.	○	○	○	○	○	○	○	○
6. Customer Satisfaction: Collaborate with customers to understand their								

requirements, and then implement a PLM system that will satisfy their needs.	○	○	○	○	○	○	○	○
7. Data Conversion: Analyze data to assure an accurate and complete migration of data from legacy systems to the PLM system	○	○	○	○	○	○	○	○
8. Global Integrated System: Implement the PLM system in a manner that provides one global engineering system that can be used by all DMS Global locations and business units. Make certain the PLM system is integrated with Enterprise Resource Planning (ERP) systems and Microsoft Excel.	○	○	○	○	○	○	○	○
9. Goals and Objectives (Scope): Identify a prioritized and limited list of clearly defined measurable goals and objectives for the PLM system.	○	○	○	○	○	○	○	○
10. Implementation Strategy: Establish an implementation strategy that deploys the PLM system in a phased approach.	○	○	○	○	○	○	○	○
11. Past Experience (Lessons Learned): Review past experience with PLM system implementation and apply lessons learned.	○	○	○	○	○	○	○	○
12. PLM System Evaluation and Selection: Identify, evaluate, and select the PLM system that not only meets short-term information and process needs, but also provides a foundation for long-term global growth.	○	○	○	○	○	○	○	○
13. Project Management: Provide for the ongoing management (planning, monitoring, and controlling) of the scope, schedule, resources, cost, and risk of the PLM system implementation.	○	○	○	○	○	○	○	○
14. Project Team (Resources): Assemble a team of technically competent individuals who understand the engineering needs of DMS Global and who are willing to work on the PLM system implementation. Give the team adequate time to work on the project.	○	○	○	○	○	○	○	○
15. Risk Management (Quality Assurance): Identify and assess risks. Establish a risk management plan that assures the quality of the PLM system implementation.	○	○	○	○	○	○	○	○
16. Timeline (Schedule): Create a realistic implementation timeline, monitor progress, and adjust as necessary.	○	○	○	○	○	○	○	○
17. Testing: Create and execute a system test plan, including simulated real-world test cases, that validates the PLM system meets expectations.	○	○	○	○	○	○	○	○
18. Top Management Support: Assemble a global team of top managers (steering committee) who are committed to the successful implementation of the PLM system. The team establishes goals and objectives, monitors progress, allocates human and financial	○	○	○	○	○	○	○	○

resources, and resolves conflicts.								
19. Training: Provide initial (short-term) and ongoing (long-term) high-quality training so that users know how to do their jobs in the PLM system. Support the training with good documentation and manuals.	○	○	○	○	○	○	○	○
20. User Satisfaction: Collaborate with users to understand their requirements, and then implement a PLM system that will satisfy their needs.	○	○	○	○	○	○	○	○

In the space below, please add critical success factors for the Realization Phase that you feel were missing from the preceding standard list.

Please number each critical success factor you add; provide a description of the critical success factor; and indicate the importance rating (from 1 to 7). For example:

1. First additional critical success factor description. Importance Rating = 4.
2. Second additional critical success factor description. Importance Rating = 7.

5.4 Final Preparation Phase critical success factors.

Please rank the importance of each of the following critical success factors for the ...
Final Preparation Phase: Train end users and migrate legacy data.

	No Importance	Very Low Importance	Low Importance	Moderate Importance	High Importance	Very High Importance	Critical Importance	N/A
1. Business Case: Develop a business case that identifies how the PLM system will provide value through effective, efficient processes that increase revenue, profit, and productivity while allowing for continuous improvement.	○	○	○	○	○	○	○	○
2. Business Process Reengineering (Common Processes): Reengineer DMS Global processes to utilize common PLM system best practices. Minimize complexity and software customization.	○	○	○	○	○	○	○	○
3. Change Management: Develop a comprehensive, culturally sensitive, change management plan that facilitates the implementation of the PLM system.	○	○	○	○	○	○	○	○
4. Consultant (System Integrator): Identify, evaluate, and select a PLM consulting firm that is not only technically competent, but also	○	○	○	○	○	○	○	○

understands the DMS Global business and is willing to work collaboratively.								
5. Budget (Cost): Identify the project costs, allocate the necessary funds, and monitor spending against budget.	○	○	○	○	○	○	○	○
6. Customer Satisfaction: Collaborate with customers to understand their requirements, and then implement a PLM system that will satisfy their needs.	○	○	○	○	○	○	○	○
7. Data Conversion: Analyze data to assure an accurate and complete migration of data from legacy systems to the PLM system	○	○	○	○	○	○	○	○
8. Global Integrated System: Implement the PLM system in a manner that provides one global engineering system that can be used by all DMS Global locations and business units. Make certain the PLM system is integrated with Enterprise Resource Planning (ERP) systems and Microsoft Excel.	○	○	○	○	○	○	○	○
9. Goals and Objectives (Scope): Identify a prioritized and limited list of clearly defined measurable goals and objectives for the PLM system.	○	○	○	○	○	○	○	○
10. Implementation Strategy: Establish an implementation strategy that deploys the PLM system in a phased approach.	○	○	○	○	○	○	○	○
11. Past Experience (Lessons Learned): Review past experience with PLM system implementation and apply lessons learned.	○	○	○	○	○	○	○	○
12. PLM System Evaluation and Selection: Identify, evaluate, and select the PLM system that not only meets short-term information and process needs, but also provides a foundation for long-term global growth.	○	○	○	○	○	○	○	○
13. Project Management: Provide for the ongoing management (planning, monitoring, and controlling) of the scope, schedule, resources, cost, and risk of the PLM system implementation.	○	○	○	○	○	○	○	○
14. Project Team (Resources): Assemble a team of technically competent individuals who understand the engineering needs of DMS Global and who are willing to work on the PLM system implementation. Give the team adequate time to work on the project.	○	○	○	○	○	○	○	○
15. Risk Management (Quality Assurance): Identify and assess risks. Establish a risk management plan that assures the quality of the PLM system implementation.	○	○	○	○	○	○	○	○
16. Timeline (Schedule): Create a realistic implementation timeline, monitor progress, and adjust as necessary.	○	○	○	○	○	○	○	○
17. Testing: Create and execute a system test plan, including simulated real-world test cases, that validates the PLM system meets expectations.	○	○	○	○	○	○	○	○

18. Top Management Support: Assemble a global team of top managers (steering committee) who are committed to the successful implementation of the PLM system. The team establishes goals and objectives, monitors progress, allocates human and financial resources, and resolves conflicts.	○	○	○	○	○	○	○	○
19. Training: Provide initial (short-term) and ongoing (long-term) high-quality training so that users know how to do their jobs in the PLM system. Support the training with good documentation and manuals.	○	○	○	○	○	○	○	○
20. User Satisfaction: Collaborate with users to understand their requirements, and then implement a PLM system that will satisfy their needs.	○	○	○	○	○	○	○	○

In the space below, please add critical success factors for the Final Preparation Phase that you feel were missing from the preceding standard list.

Please number each critical success factor you add; provide a description of the critical success factor; and indicate the importance rating (from 1 to 7). For example:

1. First additional critical success factor description. Importance Rating = 4.
2. Second additional critical success factor description. Importance Rating = 7.

5.5 Go Live & Support Phase critical success factors.

Please rank the importance of each of the following critical success factors for the ...
Go Live & Support Phase: Activate the information system and stabilize operations.

	No Importance	Very Low Importance	Low Importance	Moderate Importance	High Importance	Very High Importance	Critical Importance	N/A
1. Business Case: Develop a business case that identifies how the PLM system will provide value through effective, efficient processes that increase revenue, profit, and productivity while allowing for continuous improvement.	○	○	○	○	○	○	○	○
2. Business Process Reengineering (Common Processes): Reengineer DMS Global processes to utilize common PLM system best practices. Minimize complexity and software customization.	○	○	○	○	○	○	○	○
3. Change Management: Develop a comprehensive, culturally sensitive,								

change management plan that facilitates the implementation of the PLM system.	○	○	○	○	○	○	○	○
4. Consultant (System Integrator): Identify, evaluate, and select a PLM consulting firm that is not only technically competent, but also understands the DMS Global business and is willing to work collaboratively.	○	○	○	○	○	○	○	○
5. Budget (Cost): Identify the project costs, allocate the necessary funds, and monitor spending against budget.	○	○	○	○	○	○	○	○
6. Customer Satisfaction: Collaborate with customers to understand their requirements, and then implement a PLM system that will satisfy their needs.	○	○	○	○	○	○	○	○
7. Data Conversion: Analyze data to assure an accurate and complete migration of data from legacy systems to the PLM system	○	○	○	○	○	○	○	○
8. Global Integrated System: Implement the PLM system in a manner that provides one global engineering system that can be used by all DMS Global locations and business units. Make certain the PLM system is integrated with Enterprise Resource Planning (ERP) systems and Microsoft Excel.	○	○	○	○	○	○	○	○
9. Goals and Objectives (Scope): Identify a prioritized and limited list of clearly defined measurable goals and objectives for the PLM system.	○	○	○	○	○	○	○	○
10. Implementation Strategy: Establish an implementation strategy that deploys the PLM system in a phased approach.	○	○	○	○	○	○	○	○
11. Past Experience (Lessons Learned): Review past experience with PLM system implementation and apply lessons learned.	○	○	○	○	○	○	○	○
12. PLM System Evaluation and Selection: Identify, evaluate, and select the PLM system that not only meets short-term information and process needs, but also provides a foundation for long-term global growth.	○	○	○	○	○	○	○	○
13. Project Management: Provide for the ongoing management (planning, monitoring, and controlling) of the scope, schedule, resources, cost, and risk of the PLM system implementation.	○	○	○	○	○	○	○	○
14. Project Team (Resources): Assemble a team of technically competent individuals who understand the engineering needs of DMS Global and who are willing to work on the PLM system implementation. Give the team adequate time to work on the project.	○	○	○	○	○	○	○	○
15. Risk Management (Quality Assurance): Identify and assess risks. Establish a risk management plan that assures the quality of the PLM system implementation.	○	○	○	○	○	○	○	○
16. Timeline (Schedule): Create a realistic implementation timeline,	○	○	○	○	○	○	○	○

monitor progress, and adjust as necessary.	○	○	○	○	○	○	○	○
17. Testing: Create and execute a system test plan, including simulated real-world test cases, that validates the PLM system meets expectations.	○	○	○	○	○	○	○	○
18. Top Management Support: Assemble a global team of top managers (steering committee) who are committed to the successful implementation of the PLM system. The team establishes goals and objectives, monitors progress, allocates human and financial resources, and resolves conflicts.	○	○	○	○	○	○	○	○
19. Training: Provide initial (short-term) and ongoing (long-term) high-quality training so that users know how to do their jobs in the PLM system. Support the training with good documentation and manuals.	○	○	○	○	○	○	○	○
20. User Satisfaction: Collaborate with users to understand their requirements, and then implement a PLM system that will satisfy their needs.	○	○	○	○	○	○	○	○

In the space below, please add critical success factors for the Go Live & Support Phase that you feel were missing from the preceding standard list.

Please number each critical success factor you add; provide a description of the critical success factor; and indicate the importance rating (from 1 to 7). For example:

1. First additional critical success factor description. Importance Rating = 4.
2. Second additional critical success factor description. Importance Rating = 7.

6.0 DMS Global Openness to New Ideas

The sixth section of the survey asks you to rate your agreement with the following five statements regarding DMS Global's openness to new ideas.

Beside each statement will be a rating scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree) that will allow you to record your level of agreement. If you are unable to judge your level of agreement then please choose the rating of N/A (Not Applicable).

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	N/A
6.1 Technical innovation, based on research results, is readily accepted.	○	○	○	○	○	○

6.2 Management actively seeks innovative ideas.	○	○	○	○	○	○
6.3 Innovation is readily accepted in program/project management.	○	○	○	○	○	○
6.4 People are penalized for new ideas that don't work.	○	○	○	○	○	○
6.5 Innovation in DMS Global is perceived as too risky and is resisted.	○	○	○	○	○	○

7.0 Open Forum

This seventh section of the survey is an open forum.

7.1 Please provide additional information you feel would be helpful to this research in the space below.

8.0 Conclusion

This eighth section completes the survey.

8.1 Do you have any additional questions, concerns, or information you feel the researcher should know? Please provide your response in the space below.

The next steps in this research are to: analyze the results of the DMS Global PLM project team member survey; develop the conceptual framework to guide global PLM system implementations; and conduct a focus group with the DMS Global PLM project steering committee. The objectives of the focus group are: to share the results of the data collection and analysis; to present the conceptual framework; and to critique the conceptual framework.

Thank you for giving your valuable time to this research project. The survey is now complete. Please click the "Finish and Save Survey" button to finalize and submit your survey response.

Share This Survey QuestionPro

Appendix G: Focus group protocol

Below is the focus group protocol. The probing questions, designed by a “P” prefix and red text, were not included in the protocol sent to the DMS Global steering committee members ahead of focus group meetings.

Introduction

Thank you for participating in the DMS global PLM project steering committee focus group meeting. The consent forms you signed for the individual in-depth interviews also cover the focus group meetings. Accordingly, no additional consent forms are required. Your privacy and confidentiality will be protected by assigning you a unique identification number. Data collected will be aggregated with other participants to create a composite picture. The firm’s privacy will be secured by using the alias “DMS Global” (representing design, manufacture, and service of heavy industry equipment on a global scale). Electronic (soft copy) data will be stored in encrypted password protected files. Paper (hard copy) data will be stored in a locked file. Data collected will be used for the purpose of this research and will not be shared or sold to other researchers. To assure the accuracy of data collection and transcription, I am making an audio recording this focus group. If you object to the audio recording, you may excuse yourself from this focus group meeting.

Objectives and Structure

This focus group will concentrate on the critical success factors (CSFs) for the implementation of a global product lifecycle management (PLM) information system arising from this research. The objectives of the focus group are twofold: first is to present the results of this research, second is to discuss the findings. To this end, the focus group protocol has been structured in eight sections with estimated time allocation as follows:

1. Review of research design ………………………………………....	5 minutes
2. CSF importance ratings by project phase ……………...	25 minutes
3. CSF importance ratings top five CSFs …………………………..	10 minutes
4. CSF Analysis of variance (ANOVA) summary by culture ………..	10 minutes
5. CSF Analysis of Variance (ANOVA) by national culture ………...	20 minutes
6. CSF Analysis of Variance (ANOVA) by professional culture ……	20 minutes
7. Open forum ……………………………………………………..	15 minutes
8. Conclusion ……………………………………………………...	5 minutes
	110 minutes

Q-01: Do you have any questions regarding the objectives or structure of the focus group meeting?

1.0 Review of Research Design.

The research design included three-stages of data collection and analysis as pictured in Figure 1.

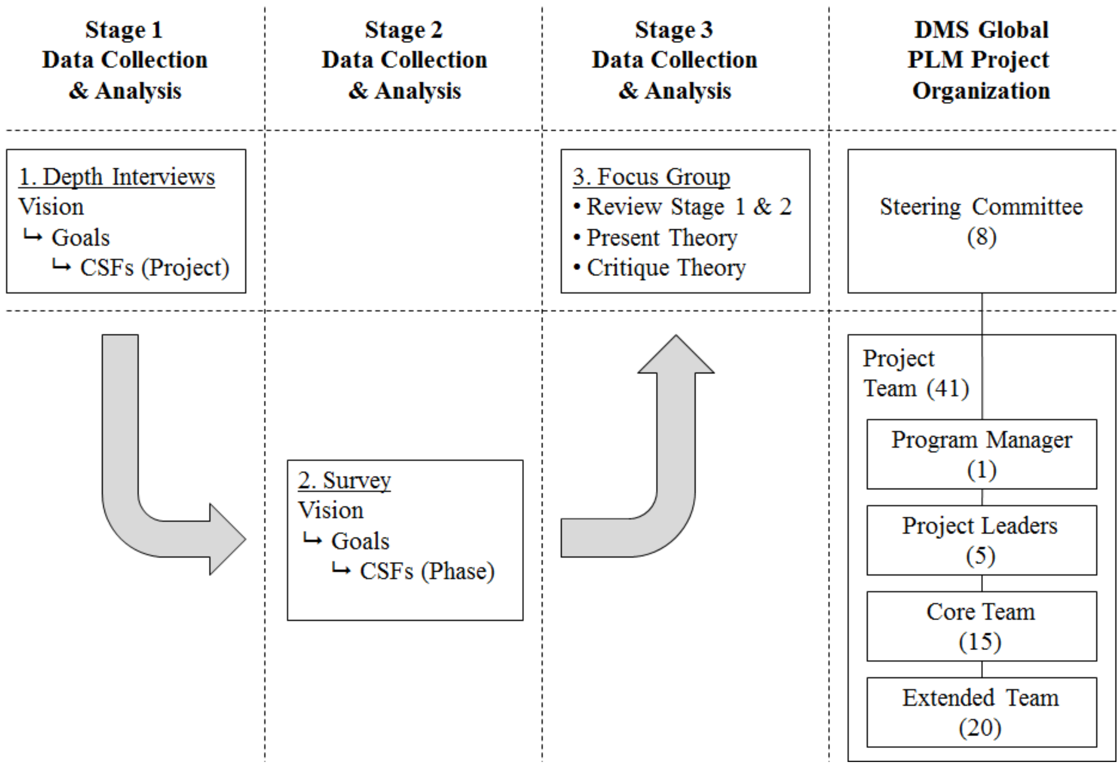


Figure 1. Research Design

Stage 1 data collection and analysis involved in-depth interviews with the eight members of the DMS Global PLM project steering committee. A key outcome of stage 1 was the identification of 20 PLM CSFs (see Appendix 1). Stage 2 data collection and analysis was an online web-based survey of the DMS Global PLM project team. The survey (developed in QuestionPro) was available in both Japanese and English and focused on rating the importance (on a 1 to 7 scale) of each of the 20 PLM CSFs from stage 1 for each of the five project phases (project preparation; blueprint; realization; final preparation; go live and support). Stage 3 data collection and analysis are two identical focus groups with the DMS Global PLM project steering committee members.

Q-02: Do you have any questions regarding the research design?

2.0 CSF Importance Ratings by Project Phase

The online web-based survey rateed the importance of the 20 DMS Global PLM CSF for each of the five project phases. Figure 2 portrays the five project phases.

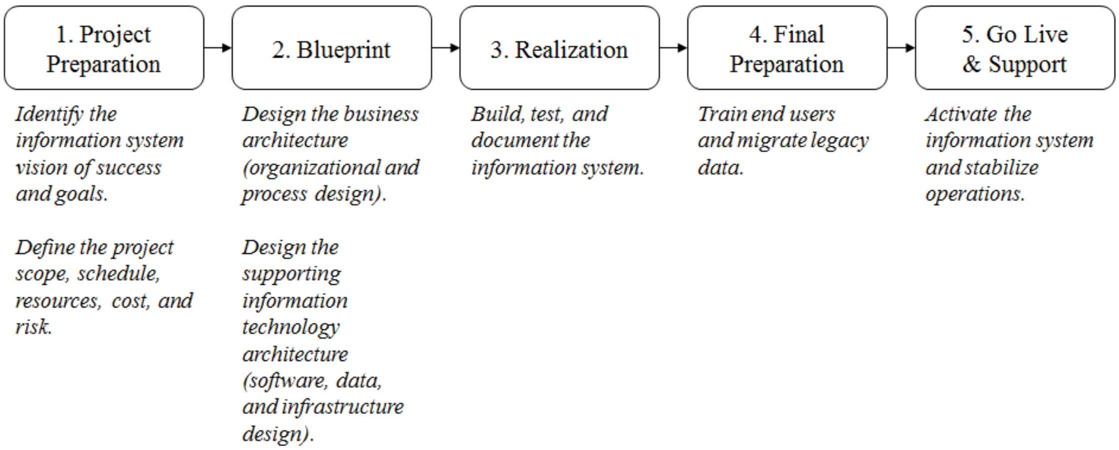


Figure 2. Project Phases

The text below each project phase in Figure 5 was included in the survey and described the primary objectives of each phase. The CSF importance rating scale was:

1. No Importance
2. Very Low Importance
3. Low Importance
4. Moderate Importance
5. High Importance
6. Very High Importance
7. Critical Importance

- o N/A (not able to judge the importance)

Tables 1 through 5 show the CSF importance rating by project phases respectively. The results are sorted in descending order by mean (average) importance rating. CSFs in bold text followed by "(S)" were identified in the academic literature as strategic in nature.

Q-03: Do you have any questions regarding the online web-based survey?

Table 1. Importance of DMS Global PLM CSFs for 01 Project Preparation Phase

Mean Order	DMS Global PLM CSF	N	Mean	Standard Deviation	Min	Max
1	01-18 **TopMgmtSupport(S)**	20	6.00	.973	4	7
2	01-02 BPRCommonProcesses	20	5.90	.968	4	7
3	01-01 **BusinessCase(S)**	20	5.80	.951	4	7
4	01-08 GlobalIntegratedSys	20	5.80	1.056	4	7
5	01-04 ConsultSysIntegrator	20	5.65	1.268	3	7
6	01-03 **ChangeMgmt(S)**	20	5.60	1.095	3	7
7	01-12 PLMSysEvalSelect	20	5.60	1.046	4	7
8	01-14 ProjTeamResources	20	5.55	.999	4	7
9	01-09 **GoalsObjectives(S)**	20	5.50	1.000	4	7
10	01-07 DataConversion	20	5.45	1.538	2	7
11	01-05 BudgetCost	20	5.35	1.182	3	7
12	01-11 PastExpLessonsLearn	20	5.35	1.137	3	7
13	01-19 Training	20	5.35	1.694	1	7
14	01-06 CustSatisfaction	20	5.25	1.517	2	7
15	01-13 **ProjMgmt(S)**	20	5.20	1.005	3	7
16	01-10 **ImplementStrategy(S)**	20	5.15	1.089	2	7
17	01-20 UserSatisfaction	20	5.15	1.496	1	7
18	01-16 TimeSchedule	20	5.05	1.317	2	7
19	01-17 Testing	20	4.95	1.669	1	7
20	01-15 RiskMgmtQA	20	4.80	1.005	3	6

Q-04: Do you agree with the importance rating of the top five CSFs for this phase?

Q-05: What observations do you have regarding the data in Table 1?

P-01: [Table 1, Mean Order 2, Column DMS Global PLM CSF] What do you think contributed to the high importance rating and low standard deviation of Business Process Reengineering (Common Processes)?

P-02: [Table 1, Mean Order 4, Column DMS Global PLM CSF] This CSF, Global Integrated System, was the only CSF identified by DMS Global that was not in the academic literature. In other words, this CSF was unique to DMS Global. This CSF is similar in nature to Business Process Reengineering (Common Processes). Together these CSFs imply that a local PLM system with custom processes by location would be viewed as a failure. Do you agree with this assessment? Why, or why not?

Table 2. Importance of DMS Global PLM CSFs for 02 Blueprint Phase

Mean Order	DMS Global PLM CSF	N	Mean	Standard Deviation	Min	Max
1	02-02 BPRCommonProcesses	16	6.00	.894	4	7
2	02-06 CustSatisfaction	16	5.56	1.153	3	7
3	02-03 **ChangeMgmt(S)**	16	5.50	1.095	3	7
4	02-04 ConsultSysIntegrator	16	5.44	1.459	1	7
5	02-18 **TopMgmtSupport(S)**	16	5.44	1.590	1	7
6	02-07 DataConversion	16	5.31	1.662	1	7
7	02-14 ProjTeamResources	16	5.31	1.448	1	7
8	02-05 BudgetCost	16	5.25	1.483	1	7
9	02-11 PastExpLessonsLearn	16	5.19	1.109	4	7
10	02-13 **ProjMgmt(S)**	16	5.06	.998	3	6
11	02-15 RiskMgmtQA	16	5.06	.998	4	7
12	02-01 **BusinessCase(S)**	16	5.00	1.932	1	7
13	02-16 TimeSchedule	16	5.00	1.414	1	7
14	02-20 UserSatisfaction	16	5.00	1.155	2	6
15	02-10 **ImplementStrategy(S)**	16	4.94	1.436	1	6
16	02-12 PLMSysEvalSelect	16	4.94	1.482	1	7
17	02-17 Testing	16	4.94	1.731	1	7
18	02-09 **GoalsObjectives(S)**	16	4.81	1.377	1	7
19	02-08 GlobalIntegratedSys	16	4.69	1.702	1	7
20	02-19 Training	16	4.38	2.029	1	7

Q-06: Do you agree with the importance rating of the top five CSFs for this phase?

Q-07: What observations do you have regarding the data in Table 2?

P-03: [Table 2, Mean Order 2] Customer Satisfaction is new to the top five. In the previous phase, Customer Satisfaction was rateed 14 of 20; or in the bottom half. What do you think contributed to the significant jump in importance?

Table 3. Importance of DMS Global PLM CSFs for 03 Realization Phase

Mean Order	DMS Global PLM CSF	N	Mean	S.Dev	Min	Max
1	03-17 Testing	19	5.79	1.437	2	7
2	03-13 **ProjMgmt(S)**	19	5.53	.905	4	7
3	03-19 Training	19	5.47	1.577	2	7
4	03-15 RiskMgmtQA	19	5.42	1.121	4	7
5	03-06 CustSatisfaction	19	5.37	1.212	3	7
6	03-07 DataConversion	19	5.37	1.422	2	7
7	03-16 TimeSchedule	19	5.37	1.535	1	7
8	03-14 ProjTeamResources	19	5.32	1.529	1	7
9	03-09 **GoalsObjectives(S)**	19	5.26	1.240	1	6
10	03-02 BPRCommonProcesses	19	5.21	1.084	3	7
11	03-04 ConsultSysIntegrator	19	5.21	1.548	1	7
12	03-10 **ImplementStrategy(S)**	19	5.21	1.316	1	7
13	03-18 **TopMgmtSupport(S)**	19	5.21	1.813	1	7
14	03-20 UserSatisfaction	19	5.21	1.228	2	7
15	03-11 PastExpLessonsLearn	19	5.16	1.772	1	7
16	03-08 GlobalIntegratedSys	19	5.11	1.524	1	7
17	03-03 **ChangeMgmt(S)**	19	4.89	1.663	1	7
18	03-05 BudgetCost	19	4.89	1.487	1	7
19	03-12 PLMSysEvalSelect	19	4.63	1.862	1	7
20	03-01 **BusinessCase(S)**	19	4.26	1.968	1	7

Q-08: Do you agree with the importance rating of the top five CSFs for this phase?

Q-09: What observations do you have regarding the data in Table 3?

Table 4. Importance of DMS Global PLM CSFs for 04 Final Preparation Phase

Mean Order	DMS Global PLM CSF	N	Mean	S.Dev	Min	Max
1	04-13 **ProjMgmt(S)**	19	5.84	.834	4	7
2	04-19 Training	19	5.79	1.084	3	7
3	04-07 DataConversion	19	5.68	1.108	4	7
4	04-15 RiskMgmtQA	19	5.47	1.020	4	7
5	04-16 TimeSchedule	19	5.47	1.679	1	7
6	04-17 Testing	19	5.47	1.504	2	7
7	04-06 CustSatisfaction	19	5.37	1.461	2	7
8	04-20 UserSatisfaction	19	5.37	1.422	2	7
9	04-14 ProjTeamResources	19	5.32	1.635	1	7
10	04-18 **TopMgmtSupport(S)**	19	5.21	1.686	1	7
11	04-05 BudgetCost	19	5.05	1.682	1	7
12	04-08 GlobalIntegratedSys	19	5.00	1.700	1	7
13	04-03 **ChangeMgmt(S)**	19	4.95	1.508	1	7
14	04-04 ConsultSysIntegrator	19	4.89	1.792	1	7
15	04-10 **ImplementStrategy(S)**	19	4.89	1.449	1	6
16	04-11 PastExpLessonsLearn	19	4.89	1.595	1	7
17	04-09 **GoalsObjectives(S)**	19	4.84	1.500	1	7
18	04-02 BPRCommonProcesses	19	4.68	1.734	1	7
19	04-12 PLMSysEvalSelect	19	4.42	1.981	1	7
20	04-01 **BusinessCase(S)**	19	4.16	2.007	1	7

Q-10: Do you agree with the importance rating of the top five CSFs for this phase?

Q-11: What observations do you have regarding the data in Table 4?

Table 5. Importance of DMS Global PLM CSFs for 05 Go Live & Support Phase

Mean Order	DMS Global PLM CSF	N	Mean	S.Dev	Min	Min
1	05-19 Training	19	5.84	1.119	3	7
2	05-13 **ProjMgmt(S)**	19	5.53	1.219	2	7
3	05-20 UserSatisfaction	19	5.47	1.504	1	7
4	05-07 DataConversion	19	5.37	1.257	3	7
5	05-17 Testing	19	5.26	1.759	1	7
6	05-16 TimeSchedule	19	5.21	1.782	1	7
7	05-06 CustSatisfaction	19	5.16	1.608	1	7
8	05-08 GlobalIntegratedSys	19	5.16	1.573	1	7
9	05-14 ProjTeamResources	19	5.11	1.761	1	7
10	05-11 PastExpLessonsLearn	19	5.05	1.985	1	7
11	05-03 **ChangeMgmt(S)**	19	5.00	1.563	1	7
12	05-15 RiskMgmtQA	19	5.00	1.155	2	6
13	05-18 **TopMgmtSupport(S)**	19	4.95	1.810	1	7
14	05-04 ConsultSysIntegrator	19	4.68	1.887	1	7
15	05-05 BudgetCost	19	4.63	1.978	1	7
16	05-10 **ImplementStrategy(S)**	19	4.63	1.802	1	7
17	05-09 **GoalsObjectives(S)**	19	4.58	1.610	1	7
18	05-02 BPRCommonProcesses	19	4.53	2.118	1	7
19	05-12 PLMSysEvalSelect	19	4.42	2.090	1	7
20	05-01 **BusinessCase(S)**	19	4.26	2.104	1	7

Q-12: Do you agree with the importance rating of the top five CSFs for this phase?

Q-13: What observations do you have regarding the data in Table 5?

P-04: [Table 5, Mean Order 5] At this phase in the project, the PLM system is ready to be implemented, or has been implemented, and the focus is on stabilizing the system post go-live. It appears to me it is now too late for testing. Why do you think testing remains in the top five?

3.0 CSF Importance Ratings Top Five CSFs

This section of the focus group considers only the five CSFs with the highest importance rating for all five project phases. Table 6 displays the top five ranked CSFs for each project phase sorted by mean order.

Table 6. Top Five Ranked CSFs for all Project Phases

Mean Order	01Project Preparation Phase	02 Blueprint Phase	03 Realization Phase	04 Final Preparation Phase	05 Go Live & Support Phase
1	18 **TopMgmtSupport(S)**	02 BPRCommonProcesses	17 Testing	13 **ProjMgmt(S)**	19 Training
2	02 BPRCommonProcesses	06 CustSatisfaction	13 **ProjMgmt(S)**	19 Training	13 **ProjMgmt(S)**
3	01 **BusinessCase(S)**	03 **ChangeMgmt(S)**	19 Training	07 DataConversion	20 UserSatisfaction
4	08 GlobalIntegratedSys	04 ConsultSysIntegrator	15 RiskMgmtQA	15 RiskMgmtQA	07 DataConversion
5	04 ConsultSysIntegrator	18 **TopMgmtSupport(S)**	06 CustSatisfaction	16 TimeSchedule	17 Testing

Q-14: What observations do you have regarding the data in Table 6?

From the 25 CSFs in Table 6 there are 14 unique CSFs. Table 7 shows the unique CSFs with their recurrence by project phase. The rows of Table 8 are arranged from top to bottom so that recurrence of CSFs flows from left to right as the project progresses in time through the five lifecycle phases.

P-05: [Table 6, Column Heading 02 Blueprint Phase] It could be argued Project Preparation and Blueprint are the strategic phases of the project lifecycle as they define the vision of success, goals, and the design of the system. It follows then, that the top five CSF for these phases would be strategic in nature by the academic literature. When I consider the top five CSFs for these first two project phases, they do appear to be strategic in nature with the exception of Consultant/Systems Integrator. I believe the academic literature should have flagged these CSFs as strategic. What is your perspective?

P-06: [Table 5, Mean Order 5, Column 2] Top Management Support falls out of the top five after the Blueprint phase. The academic literature consistently had Top Management Support in the top five for all phase of the project lifecycle. Further, my professional experience is Top Management support remains critical during the Final Preparation Phase and Go Live & Support Phase because this is when the implementation of the new system moves from concept to reality causing fear, uncertainty, and doubt to increase. Accordingly, this is when top management support was instrumental in calming fears. What aspects of the DMS Global culture do you see that would discount the necessity for Top Management Support in later project phases?

Table 7. Recurrence of Top Five Ranked CSFs by Project Phase

Ln No	DMS Global PLM CSF	01Project Preparation Phase	02 Blueprint Phase	03 Realization Phase	04 Final Preparation Phase	05 Go Live & Support Phase	Recurrence
1	01 **BusinessCase(S)**	X					1
2	08 GlobalIntegratedSys	X					1
3	02 BPRCommonProcesses	X	X				2
4	04 ConsultSysIntegrator	X	X				2
5	18 **TopMgmtSupport(S)**	X	X				2
6	03 **ChangeMgmt(S)**		X				1
7	06 CustSatisfaction		X	X			2
8	16 TimeSchedule			X			1
9	15 RiskMgmtQA			X	X		2
10	13 **ProjMgmt(S)**			X	X	X	3
11	19 Training			X	X	X	3
12	17 Testing			X		X	2
13	07 DataConversion				X	X	2
14	20 UserSatisfaction					X	1
	Totals	5	5	6	4	5	25

Q-15: What observations do you have regarding the data in Table 7?

P-07: [Table 7, Line No 11, Column Recurrence] Project Management and Training have the highest recurrence across project phases among the top five CSFs. What insights does this give you to the psyche (mental and emotional state) of the project team who completed the survey?

P-08: [Table 7, Line No 14, Column DMS Global PLM CSFs] It appears to me that it is too late in the project cycle to consider User Satisfaction as a CSF. For example, if User Satisfaction was not considered during the Project Preparation phase (ranked 17 of 20) or the Blueprint Phase (ranked 14 of 20) then little can be done at Go Live & Support to provide for User Satisfaction. Do you feel changes should be made in the DMS Global PLM project to ensure User Satisfaction is addressed earlier in the project lifecycle? If so, what changes do you recommend?

4.0 CSF Analysis of Variance (ANOVA) Summary by Culture

Stage 2 survey data analysis utilized analysis of variance (ANOVA) to look for statistically significant differences (less than 0.05) in the importance rating of PLM CSFs between not only Japanese and US associates (national culture), but also engineering and IT associates (professional culture). There were 22 CSFs with statistically significant differences in importance rating as indicated in Table 8.

Table 8. Count of CSFs with Statistically Significant Differences by Cluture

Project Phase	National Culture	Professional Culture	Total
01 Project Preparation	2	3	5
02 Blueprint	0	0	0
03 Realization	2	2	4
04 Final Preparation	1	6	7
05 Go Live & Support	0	6	6
Total	5	17	22

Q-16: Would you have expected differences to be more pronounced in national or professional culture?

Q-17: What observations do you have regarding the data in Table 8?

P-09: [Table 8, Row 02, Column Project Phase] Why do you think there were no CSFs with statistically significant differences in the Blueprint Phase?

5.0 CSF Analysis of Variance (ANOVA) by National Culture

The 22 PLM CSFs in Table 8 represent areas of potential conflict worthy of additional management care because the difference in the importance rating of the CSFs by either national culture or professional culture was statistically significant. In other words, the various culture groups had a significant difference of opinion regarding the importance of 22 CSFs. Table 9 narrows the focus to the CSFs with statistically significant differences for national culture. Table 9 has 11 columns defined as follows:

1. Ln No: A sequential line number to facilitate communication.
2. Project Phase: The project phase in which the statistically significant difference arose.
3. Mean Order: The 20 PLM CSFs for each phase where sorted in descending mean order in Tables 1 through 5.
4. DMS Global PLM CSF: The PLM CSF with a statistically significant difference.
5. Sig: The ANOVA significance value calculated by SPSS. A value less that 0.05 is statistically significant. The smaller the value, the more significant the differences between the national culture groups.
6. Japan N: The number of Japanese associates who rated the importance of the PLM CSF.
7. Japan Mean: The mean of the importance rating of the PLM CSF for Japanese associates.
8. Japan Std Dev: The standard deviation of the importance rating of the PLM CSF for Japanese associates.
9. US N: The number of US associates who rateed the importance of the PLM CSF.
10. US Mean: The mean of the importance rating of the PLM CSF for US associates.
11. US Std Dev: The standard deviation of the importance rating of the PLM CSF US associates.

The rows in Table 9 are sorted by project phase, and then mean order.

Table 9.CSFs with Statistically Significant Differences by National Culture

Ln No	Project Phase	Mean Order	DMS Global PLM CSF	Sig	Japan N	Japan Mean	Japan Std Dev	US N	US Mean	US Std Dev
1	01 Project Preparation	1	01-18 **TopMgmtSupport(S)**	0.001	8	5.00	0.756	16	6.37	0.806
2	01 Project Preparation	6	01-03 **ChangeMgmt(S)**	0.044	8	5.00	1.309	16	5.88	0.719
3	03 Realization	1	03-17 Testing	0.000	8	4.50	1.414	16	6.44	0.727
4	03 Realization	14	03-20 UserSatisfaction	0.027	8	4.5	1.414	15	5.60	0.828
5	04 Final Preparation	8	04-20 UserSatisfaction	0.500	7	5.14	1.069	15	5.53	1.457

Two CSFs with a statistically significant difference have mean order number one (i.e. the highest mean importance rating for the project phase).

12. 01-18 **TopMgmtSupport(S)**

13. 03-17 Testing

One CSFs with statistically significant difference recurred across project phases.

1. xx-20 UserSatisfaction (realization, final preparation)

Figure 3 is a graphical representation of the data in Table 9.

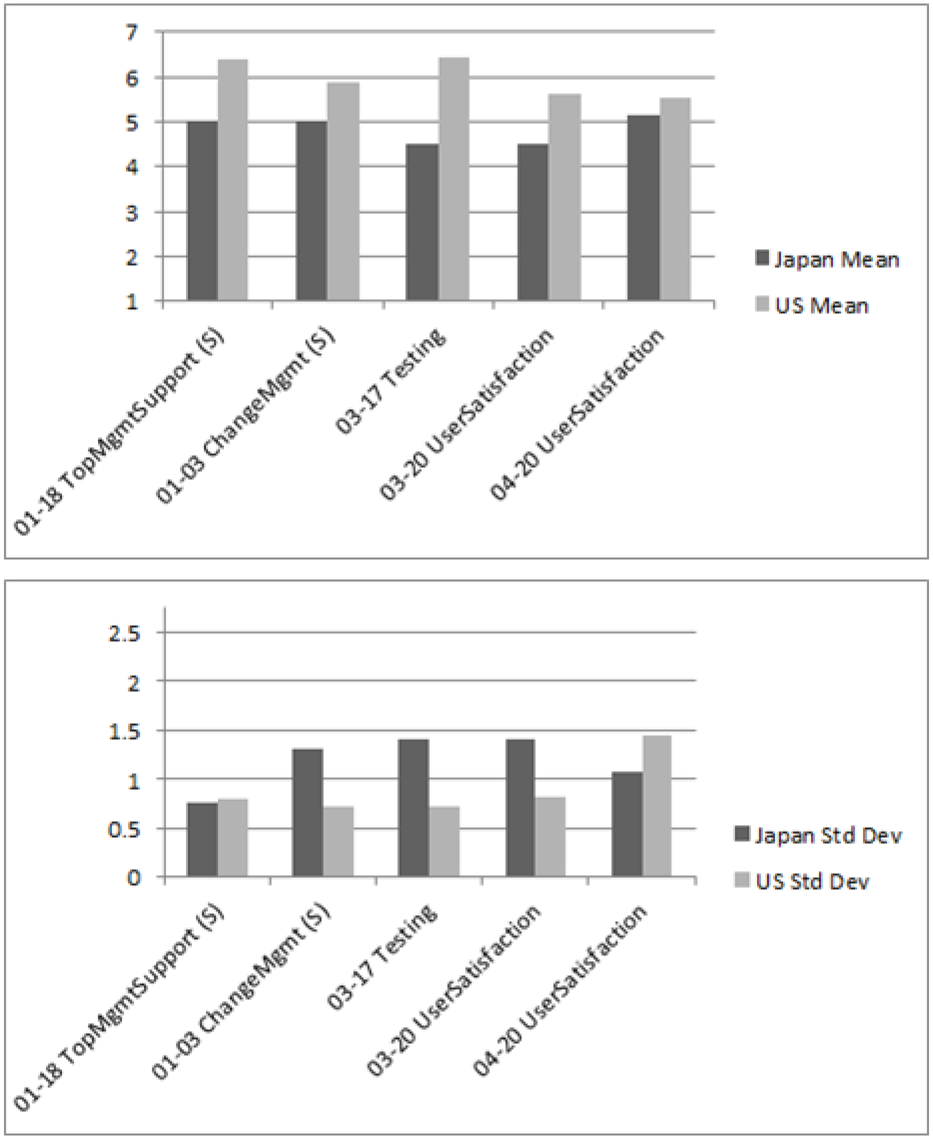


Figure 3. Graphs of CSFs with Statistically Significant Differences(from Table 9) by National Culture

Q-18: Are you surprised by any of the CSFs with statistically significant differences in Table 9 or Figure 3?

Q-19: Which CSFs with statistically significant differences in Table 9 or Figure 3 do you feel represent areas of potential conflict worthy of additional management care?

Q-20: What do you feel are the root causes of the statistically significant differences for the CSFs in Table 9 or Figure 3?

Q-21: What observations do you have regarding the data in Table 9 or Figure 3?

P-10: [Table 9, Line No 4, and Line No 5] (*** omit if time short ***) As noted earlier, User Satisfaction is considered too late in the project lifecycle. Here we find statistically significant differences between the Japan and US assessment of importance. This indicates to me this CSF could become problematic. Do you agree? Why, or why not?

P-11: [Table 9, Line No 1, and Line No 3] Of the CSFs with statistically significant difference, I would be most concerned with Top Management Support and Testing because they had mean rank 1 for the Project Preparation phase and Realization phase respectively. Do you agree? If so, what actions, if any, should be taken to mitigate this risk?

P-12: [Figure 3, General] When examining the data in Figure 3, Japan scored the mean importance consistently lower than the US, but had higher standard deviation for 3 of 5 CSFs. Do you have any insight into these results?

6.0 CSF Analysis of Variance (ANOVA) by Professional Culture

Table 10 focuses on the CSFs with statistically significant differences for professional culture. Table 10 has 11 columns defined as follows:

1. Ln No: A sequential line number to facilitate communication.
2. Project Phase: The project phase in which the statistically significant difference arose.
3. DMS Global PLM CSF: The PLM CSF with a statistically significant difference.
4. Mean Order: The 20 DMS Global PLM CSFs for each phase where sorted in descending mean order in Tables 1 through 5.
5. Sig: The ANOVA significance value calculated by SPSS. A value less that 0.05 is statistically significant. The smaller the value, the more significant the differences between the national culture groups.
6. Eng N: The number of engineering associates who rated the importance of the PLM CSF.
7. Eng Mean: The mean of the importance rating of the PLM CSF for engineering associates.
8. Eng Std Dev: The standard deviation of the importance rating of the PLM CSF for engineering associates.
9. IT N: The number of IT associates who rate the importance of the PLM CSF.
10. IT Mean: The mean of the importance rating of the PLM CSF for IT associates.
11. IT Std Dev: The standard deviation of the importance rating of the PLM CSF IT associates.

The rows in Table 10 are sorted by project phase, and then mean order.

Table 10. DMS Global PLM CSF ANOVA Summary for Professional Culture

Ln No	Project Phase	Mean Order	DMS Global PLM CSF	Sig	Eng N	Eng Mean	Eng Std Dev	IT N	IT Mean	IT Std Dev
1	01 Project Preparation	8	01-14 ProjectTeamResources	0.006	15	5.27	0.961	9	6.33	0.500
2	01 Project Preparation	9	01-09 **GoalsObjectives(S)**	0.037	15	5.27	0.884	9	6.11	0.928
3	01 Project Preparation	12	01-11 PastExpLessonsLearn	0.033	15	5.67	1.113	9	4.56	1.236
4	03 Realization	15	03-11 PastExpLessonsLearn	0.017	15	5.67	1.234	8	4.00	1.852
5	03 Realization	19	03-12 PLMSysEvalSelect	0.047	15	5.20	1.474	6	3.50	2.074
6	04 Final Preparation	5	01-16 TimeSchedule	0.037	16	6.00	1.000	8	4.63	1.996
7	04 Final Preparation	7	04-06 CustSatisfaction	0.048	15	5.80	1.265	8	4.63	1.302
8	04 Final Preparation	15	04-10 **ImplementStrategy(S)**	0.012	15	5.53	0.743	7	4.00	1.915
9	04 Final Preparation	16	01-11 PastExpLessonsLearn	0.027	15	5.53	1.060	8	4.13	1.808
10	04 Final Preparation	17	04-09 **GoalsObjectives(S)**	0.028	15	5.33	0.900	6	3.83	2.041
11	04 Final Preparation	19	04-12 PLMSysEvalSelect	0.043	14	5.07	1.385	6	3.17	2.563
12	05 Go Live & Support	3	05-20 UserSatisfaction	0.030	15	5.93	0.961	7	4.57	1.813
13	05 Go Live & Support	5	05-17 Testing	0.028	14	5.79	0.975	6	4.00	2.449
141	05 Go Live & Support	10	05-11 PastExpLessonsLearn	0.004	15	5.80	1.082	6	3.33	2.422
15	05 Go Live & Support	14	05-04 ConsultSysIntegrator	0.003	14	5.43	1.158	6	3.00	2.098
16	05 Go Live & Support	16	05-10 **ImplementStrategy(S)**	0.015	14	5.43	1.016	8	3.63	2.200
17	05 Go Live & Support	17	05-09 **GoalsObjectives(S)**	0.036	14	5.07	0.829	6	3.50	2.345

Four CSFs with statistically significant difference recurred across project phases.

12. xx-09 **GoalsObjectives(S)**: project preparation, final preparation, go live & support

13. xx-10 **ImplementStrategy(S)**: final preparation, go live & support

14. xx-11 PastExpLessonsLearn: project preparation, realization, final preparation, go live & support

15. xx-12 PLMSysEvalSelect: realization, final preparation

Figure 4 is a graphical representation of the data in Table 10.

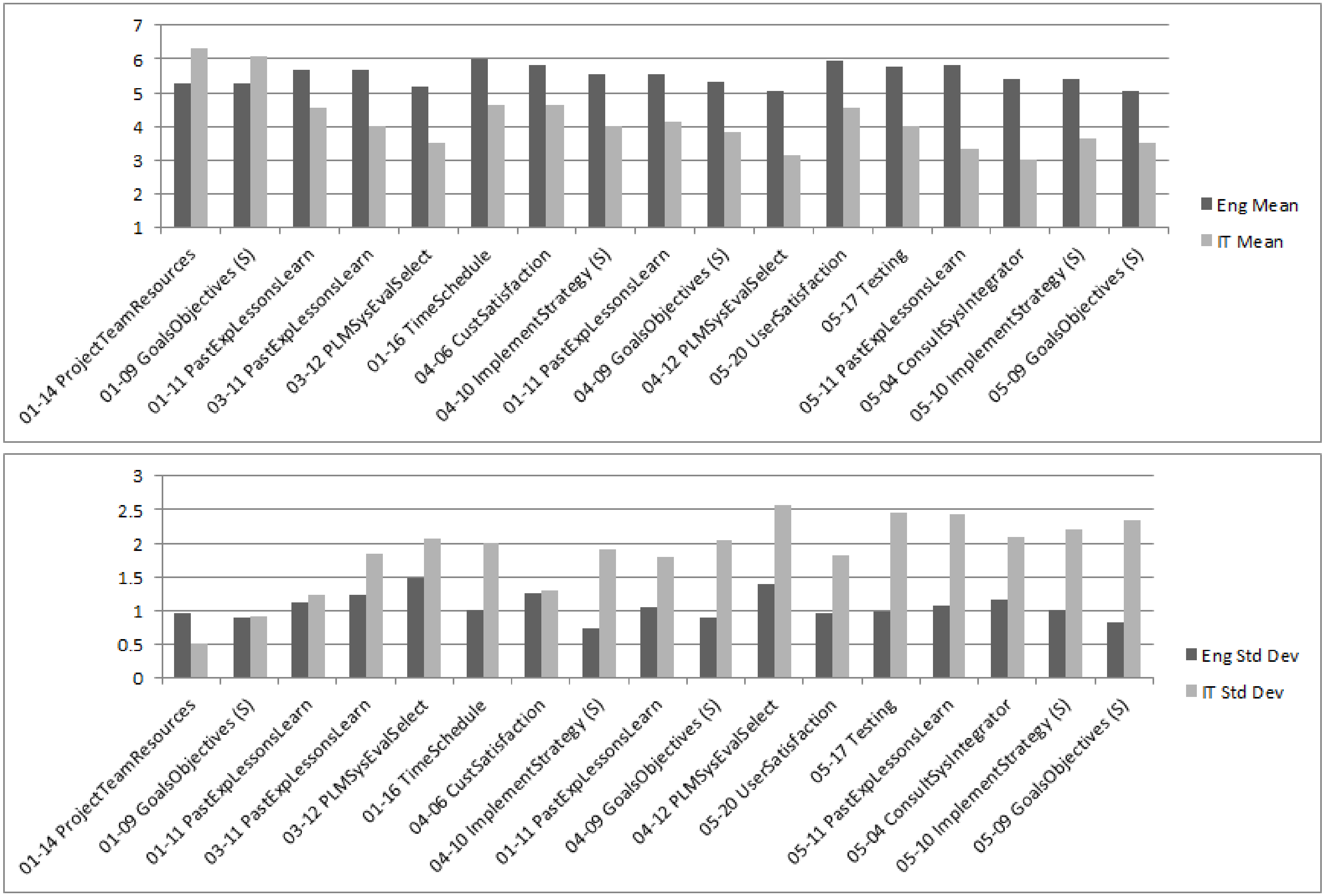


Figure 4. Graphs of CSFs with Statistically Significant Differences (from Table 10) by Professional Culture

Q-22: Are you surprised by any of the CSFs with statistically significant differences in Table 10 or Figure 4?

Q-23: Which CSFs with statistically significant differences in Table 9 or Figure 4 do you feel represent areas of potential conflict worthy of additional management care?

Q-24: What do you feel are the root causes of the statistically significant differences for the CSFs in Table 10 or Figure 4?

Q-25: What observations do you have regarding the data in Table 10 or Figure 4?

P-13: [Figure 4] Considering Figure 4, IT rated importance consistently lower than Engineering for 15 of 17 CSFs. What does this indicate about the culture of IT versus Engineering?

P-14: [Figure 4] Similarly, IT had larger standard deviation than Engineering for 16 of 17 CSFs indicating a wide range of opinion regarding the importance of the CSFs. What do you think are the causes of the variance in opinion among IT associates?

7.0 Open Forum

The final activity in the focus group is an open forum where each participant is encouraged to provide individual feedback. Accordingly, I will ask each participant one-by-one the following two questions.

Q-26: Do you have any questions regarding the research results?

Q-27: Do you have any additional information that you feel would be helpful to this research?

P-15: [Conclusion General] Given the data and results presented in the Focus Group, are there any areas of this project you would approach differently? If so, please provide examples.

8.0 Conclusion

This concludes the focus group meeting. Thank you again for giving your valuable time to this research project. It is my sincere hope that DMS Global as benefited from their participation. I wish you success as you complete the PLM information system implementation.

Appendix 1 – DMS Global PLM CSFs

English	Japanese
1. Business Case: Develop a business case that identifies how the PLM system will provide value through effective, efficient processes that increase revenue, profit, and productivity while allowing for continuous improvement.	1. ビジネスケース： 今後の改善の余地を残しながら、収入、利益、および、生産性を向上させるのに、PLMシステムが、如何に有効、且つ、効率の良い方法で、その価値を高めるかを定めるビジネスケースを開発する。
2. Business Process Reengineering (Common Processes): Reengineer DMS Global processes to utilize common PLM system best practices. Minimize complexity and software customization.	2. ビジネス プロセス リエンジニアリング(一般化)：エリオットグループが提唱する最善の一般化されたプロセスをそのケース、ケースに応じて再構築(リエンジニアリング)する。複雑化を避けるため、また、ソフトの特注化を最小限にする。
3. Change Management: Develop a comprehensive, culturally sensitive, change management plan that facilitates the implementation of the PLM system.	3. 経営プランの変更： PLMシステムのプランの実行を可能にするための広範囲な、異文化を考慮した経営プランの変更を開発する。
4. Consultant (System Integrator): Identify, evaluate, and select a PLM consulting firm that is not only technically competent, but also understands the DMS Global business and is willing to work collaboratively.	4. コンサルティング(システムのインテグレーター)： 能力のみならず、エリオットグループの方針を十分に理解し、協力していくコンサルティング会社を明確にし、評価した上で厳選する。
5. Budget (Cost): Identify the project costs, allocate the necessary funds, and monitor spending against budget.	5. 予算(費用)： プロジェクトにかかる費用を算定し、資源を配分し、予算と費用をモニターする。
6. Customer Satisfaction: Collaborate with customers to understand their requirements, and then implement a PLM system that will satisfy their needs.	6. 顧客満足度： 顧客のニーズを見つけ出すために顧客と十分に接触し、彼らが満足するPLMシステムを提案する。
7. Data Conversion: Analyze data to assure an accurate and complete migration of data from legacy systems to the PLM system	7. 収集情報の変換： 従来のシステムからPLMシステムへ正しく、かつ、完全な移行のために、収集された情報を分析する。

English	Japanese
8. Global Integrated System: Implement the PLM system in a manner that provides one global engineering system that can be used by all DMS Global locations and business units (Engineered Products, Industrial Products, and Global Service). Make certain the PLM system is integrated with Enterprise Resource Planning (ERP) systems and Microsoft Excel.	8. グローバル的システム： 全てのエリオットグループの支社や支店、または事業分野（、技術的製品や、工業製品、グローバルサービス産業）の異なるビジネスによっても採用可能なグローバルなPLMシステムを提案する。当該PLMシステムは、エンタプライズ リソース プラニング(ERP)システムおよびマイクロソフト エクセルと互換性がある必要がある。
9. Goals and Objectives (Scope): Identify a prioritized and limited list of clearly defined measurable goals and objectives for the PLM system.	9. 目標と目的(スコープ)： 当PLMシステムの目的と目標を明確に定義し、その達成度を計測可能のようにして、重要度順にリストする。
10. Implementation Strategy: Establish an implementation strategy that deploys the PLM system in a phased approach.	10. 実行戦略：当PLMシステムを段階的に展開できるように、その実行戦略工程を構築する。
11. Past Experience (Lessons Learned): Review past experience with PLM system implementation and apply lessons learned.	11. 過去の経験(学んだ事)： 過去のPLMシステム実行の経験を振り返り、その経験を活用する。
12. PLM System Evaluation and Selection: Identify, evaluate, and select the PLM system that not only meets short-term information and process needs, but also provides a foundation for long-term global growth.	12. 最適PLMシステムの選定： 短期のニーズをかなえるのみだけでなく、長期戦略の基礎をも作り上げる最適PLMシステムを明確にし、評価した上で選定する。
13. Project Management: Provide for the ongoing management (planning, monitoring, and controlling) of the scope, schedule, resources, cost, and risk of the PLM system implementation.	13. プロジェクトの管理：当PLMシステムのスコープ、スケジュール、人的資源、コスト、及び、リスクに関する管理（プラニング、モニタリング、及び　コントロール等）を行う。
14. Project Team (Resources): Assemble a team of technically competent individuals who understand the engineering needs of DMS Global and who are willing to work on the PLM system implementation. Give the team adequate time to work on the project.	14. プロジェクトチーム(人的資源)： エリオットグループのニーズを理解し、また、PLMシステムの実行に積極的に参加する技術的に資格を備えたメンバーを選定する。プロジェクトを遂行するのに必要な十分な時間を与える。

English	Japanese
15. Risk Management (Quality Assurance): Identify and assess risks. Establish a risk management plan that assures the quality of the PLM system implementation.	15. リスクマネジメント(品質管理)：リスクを明らかにし、それについて検討する。当プロジェクトの品質を保証させるためのリスクマネジメントプランを作成する。
16. Timeline (Schedule): Create a realistic implementation timeline, monitor progress, and adjust as necessary.	16. スケジュール： 実行可能なタイムテーブルを作成し、進展状況をモニターし、必要に応じて変更を加える。
17. Testing: Create and execute a system test plan, including simulated real-world test cases, that validates the PLM system meets expectations.	17. テスト： 当PLMシステムの目的とすることが実行可能であることを確かめるために、実際に起こりうるシミュレーションのテストケースも含め、テストプランを作成し、テストする。
18. Top Management Support: Assemble a global team of top managers (steering committee) who are committed to the successful implementation of the PLM system. The team establishes goals and objectives, monitors progress, allocates human and financial resources, and resolves conflicts.	18. トップマネジメントのサポート： 当PLMシステムの成功にかかわっているトップマネジメントからなるグローバルチーム(ステアリングコミティー)を招集する。当コミティーは、目標、目的を定め、プロジェクトの進行をモニターし、人的、金銭的資源を配分し、矛盾等の解決を行う。
19. Training: Provide initial (short-term) and ongoing (long-term) high-quality training so that users know how to do their jobs in the PLM system. Support the training with good documentation and manuals.	19. トレーニング： PCMシステムのユーザーがどのようにそれを利用したらよいか理解するために、初期の段階(短期間)、及び、その後(長期)の十分なトレーニングを行う。マニュアルや、文書化されたメモ等をもってしっかりとトレーニングをサポートする。
20. User Satisfaction: Collaborate with users to understand their requirements, and then implement a PLM system that will satisfy their needs.	20. ユーザー満足度：ユーザーのニーズを見つけ出すために彼らと十分に話し合い、彼らの満足するPLMシステムを実行する。

Appendix H: Trace matrix for research questions

This appendix provides a matrix that traces from the research questions to the supporting literature. The columns in the matrix are as follows:

1. **Research Question**: This column lists the research question.
2. **Literature Supporting the Research Question**: This column provides the literature that supports the research question.

The flow of information is from the research question (column 1) to the supporting literature (column 2). Accordingly, the matrix was sorted in ascending (column 1) research question order. For each research question, the support literature is presented in ascending publication date order to provide a sense of the literature's development over time.

Research Question ➔	Literature Supporting the Research Question
RQ1: How does vision of success for global PLM IS vary by culture? RQ2: How do goals for global PLM IS vary by culture?	• Daniel (1961) observed, In retrospect it is obvious that these three companies were plagued by a common problem: inadequate management information. The data were inadequate, not in the sense of there not being enough, but in terms of relevancy for setting objectives, for shaping alternative strategies, for making decisions, and for measuring results against planned goals. (p. 111). • Bullen and Rockart (1981) provided operational definitions of the following management terms: 1. Critical Success Factors (CSFs) – CSFs are the limited

Research Question ➔	Literature Supporting the Research Question
	number of areas in which satisfactory results will ensure successful competitive performance for the individual, department or organization. CSFs are the few key areas where 'things must go right' for the business to flourish and for the managers goals to be attained. 2. Strategy - Strategy is the pattern of the missions [vision], objectives, policies, and significant resource utilization plans stated in such a way as to define what business the company is in (or is not to be in) and the kind of company it is or is to be. A complete statement of strategy will define the product line, the markets and market segments which products are to be designed, the channels through which these markets will be reached, the means by which the operation is to be financed, the prophet objectives, the size of the organization, and the 'image' which it will project to employees, suppliers and customers. 3. Objectives - I sleep Objectives are general statements about the directions in which the firm intends to go, without stating specific targets to be reached at particular points in time.

Research Question ➔	Literature Supporting the Research Question
	4. Goals - Goals are specific targets which are intended to be reached at a given point in time. A goal is thus an operational transformation of one or more objectives. 5. Measures - Measures are specific standards which allow the calibration of performance for each critical success factor, role, or objective. Measures can either be 'soft,' that is subjective and qualitative, or 'hard,' that is objective and quantitative. 6. Problems - Problems are specific task rising to importance as a result of unsatisfactory performance or environmental changes. Problems can affect the achievement of goals or performance in a CSF area. (pp. 7–10). • Before concluding their review of the three uses of CSFs, Bullen and Rockart (1981) identified an area of significant value arising from the CSF interview process; insights into the manager's world view (p. 42). They noted, In addition to its yield for IS planning, the CSF method provides an additional, perhaps equally important, benefit for the interviewer. This benefit is a relatively deep understanding of the way in which each senior manager

Research Question ➔	Literature Supporting the Research Question
	interviewed views the world. In effect, the interviewed managers spend the interview time discussing their jobs as they see them, and the areas which they believe are most critical to them. Interviewers who have used the CSF process (in many cases the top person in information systems) have almost unanimously reported that this 'insight into top management and its view of the business' has been, by itself, of significant value to the I/S department. (pp. 42–43)
	• Rockart (1982) questioned, "What is the cause of this variation in actual CSFs" (p. 9)? He provided four answers. The first cause noted by Rockart (1982) was differences in the stage of development of the IS organization (p. 9). CSFs differ between mature and immature IS organization. The second cause was associated with the performance history of the IS organization (Rockart, 1982, p. 10). Rockart (1982) observed, "Companies in which service has been a problem often have service-oriented CSFs predominating …. Those in which I/S personal have been a particular problem will tend to stress the human factor" (p. 10). The third cause relates to top managements awareness of technology and the financial

Research Question ➔	Literature Supporting the Research Question
	position of the firm (Rockart, 1982, p. 10). The fourth, and final cause, stems from, … the perspective or 'world view' that the I/S executive has on the field and on his role in the company …. Thus CSFs are obviously a reflection of an executive's perspective on his role. They will, and do, vary with the personality of the I/S director himself. (Rockart, 1982, p. 10.) Rockart (1982) continued the imagery of "reflection" when he stated, "Just as I/S CSFs reflect an executive's views of his role, so do they mirror the executives himself" (p. 12). CSFs not only echo the role (position, duties, or practices) of a CSF, but also provide a "window into the soul" of the executive himself (his core, his values). • Karahanna et al., (2005) recognized, "… that [an] individual's workplace behavior is a function of all different cultures simultaneously" (p. 3). • Enterprises should incorporate the ideas of knowledge management into ERP and PDM in order to design processes that integrate closely with culture and positive learning (W.-T. Lin et al., 2006, p. 130).

Research Question →	Literature Supporting the Research Question
	• Hofstede, Hofstede, and Minkov (2010) defined culture as learned patterns of thinking, feeling, and acting (p. 8). According to Brynjolfsson and Hitt (1998, p. 3), for the PLM IS to improve integration and productivity, people across the DMS Global enterprise would be required to think, feel, and act differently. One integrated global PLM IS required not only new business processes and information technology, but also new ways of thinking, feeling and acting. In essence, PLM required a new culture (Hofstede et al., 2010, p. 8).
RQ3: What are the CSFs for global PLM IS implementation?	• To avoid an "information flood," Daniel (1961) advised, "… a company's information system must be discriminating and selective. It should focus on 'success factors.' In most industries there a usually three to six factors that determine success; these key jobs must be done exceedingly well for a company to be successful" (p. 116). • Rockart (1979) popularized the term "critical success factors" and described them as, "… the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organization. CSFs are the few key areas where 'things must go right' for the business to flourish" (p. 85).

Research Question ➔	Literature Supporting the Research Question
	• Boynton and Zmud (1984) foresaw the value of CSFs for IS implementation projects. They commented, "At an operational level, CSFs help ensure that critical organization information processing needs are explicitly addressed. The development of organizational CSFs and their use as a guideline for bounding and directing implementation efforts also provide a means to improve the overall integration of information systems efforts" (p. 19). • Following the analysis of CSF strengths and weaknesses, Boynton and Zmud (1984) commented, "CSFs are flexible and do not require a rigorous format in their use of interpretation. This offers an advantage as CSFs can be tailored to different applications, as is seen in the growing number of uses proposed for CSFs in MIS and other organizational domains" (Boynton & Zmud, 1984, p. 25). • The integration of CAD/CAM and ERP in 2001 was a challenging undertaking (Soliman et al., 2001, p. 612). Accordingly, Soliman, Clegg, and Tantousch (2001) recommended using CSFs to not only focus limited management attention, but also to help assure project success noting "… there appears to be some confidence and support for

Research Question ➔	Literature Supporting the Research Question
	obtaining CSF for integration of CAD/CAM systems with ERP systems" (p. 615). • Plant and Willcocks (2007) leveraged the CSFs of Somers and Nelson and conducted two longitudinal case studies that considered 22 CSFs for international ERP system implementation success (2007, p. 10). Their research yielded the following three primary findings: 1. Like the study of Somers and Nelson (2001), the importance of CSFs changed through the project lifecycle (Plant & Willcocks, 2007, p. 63). 2. The CSFs for domestic only versus international project were different (Plant & Willcocks, 2007, pp. 63–64). 3. The utilization of bilingual international vendors was a CSF in global ERP implementations (Plant & Willcocks, 2007, p. 66). • Schuh, Rozenfeld, Assmus, and Zancul (2008) observed, "… the promise of PLM has yet to be realized in most organizations" (p. 210). They offered three fundamental reasons for the limited results. First, PLM is complex and a general understanding of what it means in practice is lacking (Schuh et al., 2008, p. 210). Second, many PLM initiatives do

Research Question ➔	Literature Supporting the Research Question
	not adopt a holistic approach to the entire product lifecycle but rather focus on isolated functionality such as document management or parts classification (Schuh et al., 2008, p. 210). Third, and finally, Schuh et al. claim, "… there is a research and literature gap regarding PLM system implementation issues" (p. 210). • Kropsu-Vehkapera, Haapasalo, Harkonen, and Silvola (2009), when researching Product Data Management (PDM), a component of PLM, noted this was a relatively new area of academic research and the literature was scarce (p. 770). • Looking back over the history of CSFs, Cooper (2009) observed, "Since its initial inception, the CSF method has been adapted and extended to meet the needs of a wide range of research projects including: extensions to the domain and industries of applications; adaptations to the techniques used to elicit CSFs; and extensions to ways in which the results of CSF studies are presented" (p. 12). • Cantamessa, Montagna, and Neirotti (2012) note, most literature regarding PLM IS was technical in nature and demonstrated, "… a limited understanding of acceptance and use of such technologies in user's work" (p. 192).

Research Question ➔	Literature Supporting the Research Question
RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation?	• Davis (1979) noted, CSFs obtained from a bounded model that did not reflect reality may, in turn, not reflect reality. Further, the model may be "… restricted or bounded by experience, training, prejudice, custom, and attitude" (Davis, 1979, p. 57). In a word, the model may be restricted by "culture." • Before concluding their review of the three uses of CSFs, Bullen and Rockart (1981) identified an area of significant value arising from the CSF interview process; insights into the manager's world view (p. 42). They noted, In addition to its yield for information systems planning, the CSF method provides an additional, perhaps equally important, benefit for the interviewer. This benefit is a relatively deep understanding of the way in which each senior manager interviewed views the world. In effect, the interviewed managers spend the interview time discussing their jobs as they see them, and the areas which they believe are most critical to them. Interviewers who have used the CSF process (in many cases the top person in information systems) have almost unanimously reported that this 'insight into top management and its view of the business' has been, by itself, of significant value to the I/S department. (pp. 42–

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	stated, "Just as I/S CSFs reflect an executive's views of his role, so do they mirror the executives himself" (p. 12). CSFs not only echo the role (position, duties, or practices) of a CSF, but also provide a "window into the soul" of the executive himself (his core, his values). • Holland and Light (1999) observed, "Legacy systems encapsulate the existing business process, organization structure, culture, and information technology" (p. 31). • Enterprises should incorporate the ideas of knowledge management into ERP and PDM in order to design processes that integrate closely with culture and positive learning (W.-T. Lin et al., 2006, p. 130). • Soliman et al. (2001), while not explicitly stating culture could impact project success, hinted that interactions among groups and social structures were an important antecedent to project success. (p. 616). "Drawing from these studies, we provide a research framework to identify CSF for the integration of CAD/CAM systems with ERP systems. The literature reviewed in this study is based on the idea that successfully managed integration of CAD/CAM systems with ERP systems

Research Question ➔	Literature Supporting the Research Question
	depends on CAD/CAM management and the interactions among CAD /CAM resources (CAD/CAM staff, hardware and application software) and users, because 'the success of the information system depends on the social structures and interactions that prevail during and after the development process' (Lyytinen, 1987)" (Soliman et al., 2001, p. 616). • Drawing on the literature, Karahanna, Evaristo, and Srite et al., (2005), presented a hierarchical model, or framework, (from general to specific) of culture that includes the following five levels (p. 5): 1. Supranational (regional, ethnic, religious, linguistic). Any cultural differences that cross national boundaries or can be seen to exist in more than one nation. 2. National. Collective properties that are ascribed to citizens of countries (Hofstede 1984). 3. Professional. Focus on the distinction between loyalty to the employing organization versus loyalty to the industry (Gouldner, 1957). 4. Organizational. The social and normative glue that holds organizations together (Siehl & Martin, 1990). 5. Group. Cultural differences that are contained within a

Research Question ➔	Literature Supporting the Research Question
	single group, workgroup, or other collection of individuals at a level less than that of an organization. Karahanna et al., (2005) recognize "… that individual's workplace behavior is a function of all different cultures simultaneously" (p. 3). • Karahanna et al., (2005) commented, "We stated above that various levels of culture interact to form an individual's culture and to shape behavior. It is our contention, however, that depending on the behavior, different level of culture will have a dominant influence on an individual's actions. Building on the fact that national and supranational levels of culture influence one's values, then it follows that behaviors that involve consideration of values as a major component of the decision as to whether to engage in a behavior will be influence by national and supranational culture. On the other hand, behaviors that involve practices will more likely be influenced by professional and organizational cultures" (p. 7) • Karahanna et al. (2005) argued, "… a person's value set that eventually determines behavior does not merely consist of the values dictated by a specific culture. Rather it is an

Research Question →	Literature Supporting the Research Question

amalgamation or function of all the various levels of culture (e.g., national, organizational, professional) to which the individual belongs …" (p. 9).

- As customer demands increase and product life cycles decrease, the need to efficiently share product data between different units, companies, and countries grows (Hu et al., 2006b, p. 1). Hu, Wang, and Bidanda (2006b, p. 2) found the following four dimensions of global product engineering:
  1. Cultural differences
  2. Standards and interoperability
  3. Engineering tools
  4. Intellectual property

  When considering culture, Hu et al., (2006b, p. 2) commented, "Different societies and cultures had distinct ways of working and cultural norms that could lead to challenges when attempting cross-border collaborations."
- Enterprises should incorporate the ideas of knowledge management into ERP and PDM in order to design processes that integrate closely with culture and positive learning (W.-T. Lin et al., 2006, p. 130).

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	• Hofstede, Hofstede, and Minkov (2010) defined culture as learned patterns of thinking, feeling, and acting (p. 8). According to Brynjolfsson and Hitt (1998, p. 3), for the PLM information system to improve integration and productivity, people across the DMS Global enterprise would be required to think, feel, and act differently. One integrated global PLM information system required not only new business processes and information technology, but also new ways of thinking, feeling and acting. In essence, PLM required a new culture (Hofstede et al., 2010, p. 8).
RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs?	• The concept of theoretical framework arose from Strauss and Corbin's (1990). The first occurrence was in relation to analysis of data. They observed, Insight and understanding about a phenomenon increase as you interact with your data. This comes from collecting and asking questions about the data, making comparisons, thinking about what you see, making hypothesis, developing small theoretical frameworks (miniframeworks) about concepts and their relationships. (Strauss & Corbin, 1990, p. 43) Later, when discussing the development of a conditional matrix

Research Question ➔	Literature Supporting the Research Question
	they noted, What we want to do here, essentially, is to provide you with a framework that summarizes and integrates all we have presented previously … here we want to make the linkage very explicit and tie our method of analysis together to form an explanatory framework. (pp. 158–159) • Soliman et al. (2001), while not explicitly stating culture could impact project success, hinted that interactions among groups and social structures were an important antecedent to project success. (p. 616). "Drawing from these studies, we provide a research framework to identify CSF for the integration of CAD/CAM systems with ERP systems. The literature reviewed in this study is based on the idea that successfully managed integration of CAD/CAM systems with ERP systems depends on CAD/CAM management and the interactions among CAD /CAM resources (CAD/CAM staff, hardware and application software) and users, because 'the success of the information system depends on the social structures and interactions that prevail during and after the development process' (Lyytinen, 1987)" (Soliman et al., 2001, p. 616).

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	• Drawing on the literature, Karahanna, Evaristo, and Srite et al., (2005), presented a hierarchical model, or framework, (from general to specific) of culture that includes the following five levels (p. 5): 1. Supranational (regional, ethnic, religious, linguistic). Any cultural differences that cross national boundaries or can be seen to exist in more than one nation. 2. National. Collective properties that are ascribed to citizens of countries (Hofstede 1984). 3. Professional. Focus on the distinction between loyalty to the employing organization versus loyalty to the industry (Gouldner, 1957). 4. Organizational. The social and normative glue that holds organizations together (Siehl & Martin, 1990). 5. Group. Cultural differences that are contained within a single group, workgroup, or other collection of individuals at a level less than that of an organization. Karahanna et al., (2005) recognize "… that individual's workplace behavior is a function of all different cultures simultaneously" (p. 3).

Research Question →	Literature Supporting the Research Question
	• Early (2006) recommended, "…scholars refocus their attention away from any more of these values surveys and toward developing theories and frameworks for understanding the linkages among culture, perceptions, actions, organizations, structures, etc." (p. 928). • Plant and Willcocks (2007) leveraged the CSFs of Somers and Nelson and conducted two longitudinal case studies that considered 22 CSFs for international ERP system implementation success (2007, p. 10). Their research yielded the following three primary findings: 1. Like the study of Somers and Nelson (2001), the importance of CSFs changed through the project lifecycle (Plant & Willcocks, 2007, p. 63). 2. The CSFs for domestic only versus international project were different (Plant & Willcocks, 2007, pp. 63–64). 3. The utilization of bilingual international vendors was a CSF in global ERP implementations (Plant & Willcocks, 2007, p. 66). • Kropsu-Vehkapera (2009) et al., examined PDM practices in four large high-tech companies (p. 758). Their methodology began by defining a PDM framework to aid analysis followed

Research Question ➔	Literature Supporting the Research Question
	by qualitative interviews (p. 761). Key findings were the overall PDM activities were similar across the four companies in the study, however, the realization, or implementation, of these activities varied based on company background, or culture, and organizational status (Kropsu-Vehkapera et al., 2009, p. 770).

Appendix I: Trace matrix for in-depth interview questions

This appendix provides a matrix that traces (a) from the in-depth interview questions to the research questions and (b) from the in-depth interview questions to its supporting literature. The columns in the matrix are as follows:

1. **Research Question**: This column lists the research questions investigated by the in-depth interview question.
2. **Interview Question**: This column lists the in-depth interview question.
3. **Literature Supporting the Interview Question**: This column provides the literature that supports the in-depth interview question.

The flow is from interview question (column 2) both left to the research question (column 1) and right to the supporting literature (column 3). Accordingly, the matrix was sorted in ascending (column 2) interview question order. For each in-depth interview question, the support literature is presented in ascending publication date order to provide a sense of the literature's development over time

Research Question	← Interview Question →	Literature Supporting the Interview Question
None.	0.0 In-Depth Interview Justification	• The implementation of Rockart's (1979) CSF method involved two, and possibly three, interviews with the chief executive (p. 85). The objective of the first interview was: to understand the executive's goals,

Research Question	← Interview Question →	Literature Supporting the Interview Question
		to define the CSFs supporting the goals, to identify an initial set of measures for the CSFs, and to consider combining, restating, or eliminating CSFs (Rockart, 1979, p. 85). • Munro & Wheeler (1980) interviewed an unspecified number of senior middle level executives. The duration of the interviews were up to two and one half hours (Munro & Wheeler, 1980, p. 29). Their aim was to develop a general model which could be used by other managers faced with the challenge of defining the information needed to support management control (Munro & Wheeler, 1980, p. 28). The result of the field study was the following five step approach to determining the

Research Question	← Interview Question →	Literature Supporting the Interview Question
		information requirements for management control: 1. "Understand business unit objectives, 2. identify Critical Success Factors, 3. identify specific performance measure and standards, 4. identify data required to measure performance, and 5. identify decision and information required to implement the plan" (Munro & Wheeler, 1980, pp. 29–33). • In the first subsection, objectives of the interview, Bullen and Rockart (1981) observed managerial time is a precious and limited commodity and encouraged the interviewer to make the best use of this time (p. 45). To

Research Question	← Interview Question →	Literature Supporting the Interview Question
		that end, they recommend the following four objectives guide the interview process: 1. "To understand the interviewee's organization and the mission and role (the 'world view') of the interviewee within the context of his organization and the interview perceives them. 2. To understand the goals and objectives of the interviewee. 3. To elicit CSFs and measures from the interviewee. 4. To assist the manager in better comprehending her own information needs" (Bullen & Rockart, 1981, pp. 45–46). • In the third, and final, subsection, interview procedure, Bullen and

Research Question	← Interview Question →	Literature Supporting the Interview Question
		Rockart (1981) provided the following process for conducting the CSF interview: 1. Open the interview by provide an overview of the objectives of the interview and flow of the information to be gathered (pp. 50–52). 2. “Ask the interviewee to describe his mission and role” (p. 52). Not only does this get the interviewee talking about a subject they should know well, but also often provides insights into how he “views the world.” (pp. 52–53). 3. Gather the goals (specific targets to be achieved in a given time period) of the manager (pp. 53–54).

Research Question	← Interview Question →	Literature Supporting the Interview Question
		4. Gather the manager's CSFs (1981, pp. 53–58). • Planning efforts can be enhanced by conducting CSF interviews on multiple levels" (Boynton & Zmud, 1984, pp. 25–26).
None	1.0 Introduction which describes the purpose of the research.	• In the third, and final, subsection, interview procedure, Bullen and Rockart (1981) provided the following process for conducting the CSF interview: 1. Open the interview by provide an overview of the objectives of the interview and flow of the information to be gathered (pp. 50–52).
None	2.0 Informed consent which confirms your willingness to participate in the study.	• Robert Morris University IRB requirement.

Research Question	← Interview Question →	Literature Supporting the Interview Question
RQ1: How does vision of success for global PLM IS vary by culture? RQ2: How do goals for global PLM IS vary by culture? RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation? RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs?	3.0 Demographic Data 3.1 Country of Birth 3.2 Gender 3.3 Age 3.4 Education Level 3.5 Total Work Experience 3.6 DMS Global Job Title 3.7 DMS Global Tenure 3.8 DMS Global PLM Project Time 3.9 DMS Global PLM Project Phase 3.10 Past System Implementation Experience	• Martin (1982) chose to employ a two-phase survey methodology (p. 2). The first survey phase gathered (a) demographic data on the MIS/DP manager and his organization, (b) objectives of the MIS/DP manager to establish a context for CSFs, and (c) provided a concise explanation of CSFs and offered space for CSFs for the MIS/DP manager to list up to eight CSFs (Martin, 1982, p. 2). • The second survey included a consolidated summarization of the results of the first survey and afforded the MIS/DP managers an opportunity to review the results and then submit a revised set of CSFs (Martin, 1982, p. 2). • The demographic data included age, tenure with the organization,

Research Question	← Interview Question →	Literature Supporting the Interview Question
		educational background, title of the MIS/DP manager, and title of the individual to whom the MIS/DP manager reported (Martin, 1982, p. 3).
RQ1: How do vision of success and goals for global PLM IS vary by culture?	4.0 PLM Project Vision of Success "Vision of success" is defined as: general statements about what the PLM system will do for DMS Global when implemented. 4.1 Given this definition, please briefly describe your understanding the PLM project vision of success. 4.2 Thank you; do you have any additional	• Bullen and Rockart (1981) provided operational definitions of the following management terms: strategy [vision], objectives, goals, CSFs, measure, and problems (1981, pp. 7–10).

Research Question	← Interview Question →	Literature Supporting the Interview Question
	thoughts regarding the vision of PLM project success?	
RQ1: How does vision of success for global PLM IS vary by culture? RQ2: How do goals for global PLM IS vary by culture?	5.0 PLM Project Goals "Goals" are defined as: specific targets to be met in a period of time to realize the PLM project vision of success. 5.1 Given this definition, please briefly describe your understanding the PLM project goals. 5.2 Thank you; do you have any additional thoughts regarding the PLM project goals?	• Munro and Wheeler (1980) suggested, "… applying the CSF approach in a planning context may overcome the difficulties noted by Davis…. The key to this outcome is the explicit linkage between goals and objectives on the one hand, and critical success factors on the other. Since the margin for error on these dimensions is minimized by this linkage, an enhanced level of relevance, correctness, and completeness is inherent in the product" (p. 36). • Bullen and Rockart (1981) provided operational definitions of the following management terms:

Research Question	🡐 Interview Question 🡒	Literature Supporting the Interview Question
		strategy [vision], objectives, goals, CSFs, measure, and problems (1981, pp. 7–10).
RQ3: What are the CSFs for global PLM IS implementation?	6.0 PLM Project Critical Success Factors "Critical success factors" are defined as: the limited number of areas where things must go right in order to achieve the PLM project goals and vision of success. 6.1 Will you please tell me, in whatever order they come to mind, those things that you see as critical success factors for the DMS Global PLM project. 6.2 Let me ask the same	• Bullen and Rockart (1981) provided operational definitions of the following management terms: strategy [vision], objectives, goals, CSFs, measure, and problems (1981, pp. 7–10). • Bullen and Rockart (1981) offer the following two questions they have found useful in eliciting CSFs; with the latter two being helpful in prioritizing CSFs: ○ "Will you please tell me, in whatever order they come to mind, those things that you see as critical success factors in your job at this time?" (p.

Research Question	← Interview Question →	Literature Supporting the Interview Question
	questions concerning critical success factors in another way. In what one, two, or three areas would failure to perform well hurt the PLM project? In short, where would you most hate to see something go wrong in the PLM project? 6.3 Thank you; do you have any additional thoughts regarding PLM project critical success factors?	55) ○ "Let me ask the same questions concerning critical success factors in another way. In what one, two, or three areas would failure to perform well hurt you the most? In short, where would you most hate to see something go wrong?" (p. 55)
None.	7.0 Open Forum 7.1 Do you have any additional information you feel would be helpful to this research?	• Hackos and Redish (1998) recommend, "As part of every interview, therefore, you should ask the user if there is anything else they think you should know" (p. 293).

Research Question	← Interview Question →	Literature Supporting the Interview Question
None.	8.0 Conclusion This concludes our interview. 8.1 Do you have any additional questions, concerns, or information you feel I should know?	• Hackos and Redish (1998) recommend thanking the user for their time (p. 269)and describing what feedback will be given as a result of the study (p. 201). • Hackos and Redish (1998) recommend, "As part of every interview, therefore, you should ask the user if there is anything else they think you should know" (p. 293).

Appendix J: Trace matrix for survey questions

This appendix provides a matrix that traces (a) from the survey questions to the research questions and (b) from the survey questions to the supporting literature. The columns in the matrix are as follows:

1. **Research Question**: This column lists the research questions investigated by the survey question.
2. **Survey Question**: This column lists the survey question.
3. **Literature Supporting the Survey Question**: This column provides the literature that supports the survey question.

The flow is from survey question (column 2) both left to the research question (column 1) and right to the supporting literature (column 3). Accordingly, the matrix was sorted in ascending (column 2) survey question order. For each survey question, the support literature is presented in ascending publication date order to provide a sense of the literature's development over time

Research Question	← Survey Question →	Literature Supporting the Survey Question
None.	0.0 Survey Justification	• Martin (1982) chose to focus his study on identifying the CSFs for the MIS/DP (management information systems / data processing) organization by surveying 15 executives directly responsible for MIS/DP function (p. 2,4).

Research Question	← Survey Question →	Literature Supporting the Survey Question
		• Through an extensive review of the literature, Somers and Nelson (2001) developed a list of 22 CSFs associated with project/system implementations (p. 2). A survey instrument was developed that included clear, short descriptions of the six stages/phases of implementation and a list of the 22 CSFs (Somers & Nelson, 2001, p. 6).
None	1.0 Introduction Purpose. Organization. Confidentiality/right to privacy. Survey completion.	• While the focus of Rockart's (1979) article was on the chief executive, he did note that CSFs would be useful at each level of general management (p. 88). Rockart (1979) identified the following benefits likely to accrue by cascading CSFs through the layers of management: (1979, p. 88) ○ Helping the manager to determine factors on which to focus their attention.

Research Question	← Survey Question →	Literature Supporting the Survey Question
		○ Forcing managers to develop good measures for CSFs. ○ Clearing defining information needs and avoiding costly collection of more data than is required. ○ Movement away from reporting data that is "easy to collect" toward collection of data significant for the success of the particular management level. ○ Acknowledging that some factors are temporal and, consequently, information systems must change to meet business needs. ○ The usefulness of CSFs extends beyond information system design to information

Research Question	← Survey Question →	Literature Supporting the Survey Question
		system planning. Further, CSFs can be arranged hierarchically to aid management communication. • After individual manager CSFs are identified, they are consolidated and prioritized to determine the overall information system planning priorities (Bullen & Rockart, 1981, p. 39). • In the third, and final, subsection, interview procedure, Bullen and Rockart (1981) provided the following process for conducting the CSF interview: Open the interview by provide an overview of the objectives of the interview and flow of the information to be gathered (pp. 50–52). • Martin (1982) chose to focus his study on identifying the CSFs for the MIS/DP (management information systems / data

Research Question	← Survey Question →	Literature Supporting the Survey Question
		processing) organization by surveying 15 executives directly responsible for MIS/DP function (p. 2,4). • Through an extensive review of the literature, Somers and Nelson (2001) developed a list of 22 CSFs associated with project/system implementations (p. 2). A survey instrument was developed that included clear, short descriptions of the six stages/phases of implementation and a list of the 22 CSFs (Somers & Nelson, 2001, p. 6).
None	2.0 Demographic Data 2.1 Country of Birth 2.2 Gender 2.3 Age 2.4 Education Level 2.5 Total Work Experience 2.6 DMS Global Job Title 2.7 DMS Global Tenure	• Martin (1982) chose to employ a two-phase survey methodology (p. 2). • The second survey included a consolidated summarization of the results of the first survey and afforded the MIS/DP managers an opportunity to review the results and then submit a revised set of CSFs (Martin, 1982, p. 2).

Research Question	← Survey Question →	Literature Supporting the Survey Question
	2.8 DMS Global PLM Project Time 2.9 DMS Global PLM Project Phase 2.10 Implementation Experience	• The first survey phase gathered (a) demographic data on the MIS/DP manager and his organization, (b) objectives of the MIS/DP manager to establish a context for CSFs, and (c) provided a concise explanation of CSFs and offered space for CSFs for the MIS/DP manager to list up to eight CSFs (Martin, 1982, p. 2). The demographic data included age, tenure with the organization, educational background, title of the MIS/DP manager, and title of the individual to whom the MIS/DP manager reported (Martin, 1982, p. 3).
RQ1: How do vision of success and goals for global PLM IS vary by culture?	3.0 PLM Project Vision of Success "Vision of success" is defined as: general statements about what the PLM system will do for	• Bullen and Rockart (1981) provided operational definitions of the following management terms: strategy [vision], objectives, goals, CSFs, measure, and problems (1981, pp. 7–10).

Research Question	🡐 Survey Question 🡒	Literature Supporting the Survey Question
	DMS Global when implemented. 3.1 Given this definition, please briefly describe your understanding the PLM project vision of success in the space provided below.	
RQ2: How do goals for global PLM IS vary by culture?	4.0 PLM Project Goals "Goals" are defined as: specific targets to be met in a period of time to realize the PLM project vision of success. 4.1 Given this definition, please briefly describe your understanding the PLM project goals in the space provided below.	• Munro and Wheeler (1980) suggested, "… applying the CSF approach in a planning context may overcome the difficulties noted by Davis…. The key to this outcome is the explicit linkage between goals and objectives on the one hand, and critical success factors on the other. Since the margin for error on these dimensions is minimized by this linkage, an enhanced level of relevance, correctness, and completeness is inherent in the product" (p. 36). • Bullen and Rockart (1981) provided

Research Question	← Survey Question →	Literature Supporting the Survey Question
		operational definitions of the following management terms: strategy [vision], objectives, goals, CSFs, measure, and problems (1981, pp. 7–10).
RQ3: What are the CSFs for global PLM IS implementation? RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation?	5.0 PLM Project Critical Success Factor Importance by Project Phase The fifth section of the survey asks you to rate the importance of critical success factors for each of the five PLM project phases. "Critical success factors" are defined as: the limited number of areas where things must go right in order to achieve the PLM project goals and vision of success. 5.1.1 This first subjection	• Bullen and Rockart (1981) provided operational definitions of the following management terms: strategy [vision], objectives, goals, CSFs, measure, and problems (1981, pp. 7–10). • While gathering CSFs, Bullen and Rockart (1981) recommend aggregating CSFs provided by the interviewee if the CSFs revolve around a common management concern (p. 57). • Bullen and Rockart (1981) noted, "Some further insight into the manager is often gained by having the interviewee put CSFs in priority order" (p. 58). • Martin (1982) noted the consolidation list of general CSFs, "… were developed

Research Question	← Survey Question →	Literature Supporting the Survey Question
	allows you to rate the importance of the critical success factors for the Project Preparation phase. 5.1.2 In the space below, please add critical success factors for the Project Preparation Phase that you feel were missing from the preceding standard list of nine. 5.2.1 This second subjection allows you to rate the importance of the critical success factors for the Blueprint phase. 5.2.2 In the space below, please add critical success factors for the Blueprint Phase that you feel were	by a subjective trial and error process. Several colleagues participated in the process, but the first grouping of the managers' stated CSF's into broader organizational CSF's was done by the author on a judgment basis. Also, the names given to the resulting areas reflect the judgment of the author" (1982, p. 4). • Martin (1982) devoted several paragraphs to the description of each CSF (pp. 4–7). He observed the higher level CSF could be broken down hierarchically into a lower level CSFs. For example, "system development" breaks down into "… project selection, effective project management, ability to respond effectively to the user needs within a reasonable time frame, and the development of reliable, timely, and cost effective application systems" (Martin,

Research Question	← Survey Question →	Literature Supporting the Survey Question
	missing from the preceding standard list of nine. 5.3.1 This third subjection allows you to rate the importance of the critical success factors for the Realization phase. 5.3.2 In the space below, please add critical success factors for the Realization Phase that you feel were missing from the preceding standard list of nine. 5.4.1 This fourth subjection allows you to rate the importance of the critical success factors for the Final Preparation phase. 5.4.2 In the space below, please add critical success	1982, p. 4). • Somers and Nelson (2001) undertook an empirical study to determine not only which CSFs are most critical in the ERP implementation process, but also to which of the six stages/phases (i.e. initiation, adoption, adaptation, acceptance, routinization, and infusion) of the implementation project the CSFs applied (p. 2) • Survey respondents were asked to, "… (1) identify the degree of importance of each CSF in their ERP implementation overall, using a 5-point scale, ranging from low to critical (including NR = not applicable) and, (2) indicate in which stage of the implementation (i.e., initiation, adoption, adaption, acceptance, routinization, infusion) the particular CSF was important" (Somers

Research Question	← Survey Question →	Literature Supporting the Survey Question
	factors for the Final Preparation Phase that you feel were missing from the preceding standard list of nine. 5.5.1 This fifth subjection allows you to rate the importance of the critical success factors for the Go Live & Support phase. 5.2.2 In the space below, please add critical success factors for the Go Live & Support Phase that you feel were missing from the preceding standard list of nine.	& Nelson, 2001, p. 6). • Somers and Nelson (2001) received 86 responses (Somers & Nelson, 2001, p. 6). They calculated the mean and standard deviation for the 22 CSFs, then used the mean to sort the 22 CSFs in descending order of overall importance to the implementation to ERP systems (Somers & Nelson, 2001, pp. 6–7). Somers and Nelson (2001) also analyzed the survey data regarding to which stages/phases a CSF. For each stage/phase, they listed the five CSFs that were most frequently identified as being important for the stage/phase (Somers & Nelson, 2001, p. 7). • Frimpon (2011), during his research on the implementation of ERP in a University in Ghana, West Africa, identified 28 CSFs from the literature (p.

Research Question	← Survey Question →	Literature Supporting the Survey Question
		233). He analyzed the interrelationships between the 28 CSFs and distilled the 28 CSFs into the following five key roles: top management, technical management, process management, change management, and project management (Frimpon, 2011, pp. 240–241). A role was defined as, "… a group of CSFs identified and put together for the purpose of achieving a sub-objective of the main objective" (Frimpon, 2011, p. 233). The primary motivation for consolidating CSFs was to reduce complexity.
None	6.0 DMS Global Openness to New Ideas The sixth section of the survey asks you to rate your agreement with the following five statements	• When researching innovation, market orientation, and organizational learning, Hurley and Hult (1998) conceptualized organizational culture as an antecedent to innovativeness (p. 44). They defined innovativeness as, "… the openness to

Research Question	← Survey Question →	Literature Supporting the Survey Question
	regarding DMS Global's openness to new ideas. 6.1 Technical innovation, based on research results, is readily accepted. 6.2 Management actively seeks innovative ideas. 6.3 Innovation is readily accepted in program/project management. 6.4 People are penalized for new ideas that don't work. 6.5 Innovation in DMS Global is perceived as too risky and is resisted.	new ideas as an aspect of a firm's culture" (Hurley & Hult, 1998, p. 44). • To assess innovativeness, Hurley and Hult (1998) surveyed a large research and development organization of the US federal government and asked respondents to rate the following five statements regarding innovativeness on a 1 (not descriptive) to 5 (descriptive) Likert scale(p. 48): ○ Technical innovation, based on research results, is readily accepted. ○ Management actively seeks innovative ideas. ○ Innovation is readily accepted in program/project management. ○ People are penalized for new ideas that don't work.

Research Question	← Survey Question →	Literature Supporting the Survey Question
		○ Innovation in XYZ is perceived as too risky and is resisted. (1998, p. 49)
None.	7.0 Open Forum 7.1 Please provide additional information you feel would be helpful to this research in the space provided below.	• Hackos and Redish (1998) recommend, “As part of every interview, therefore, you should ask the user if there is anything else they think you should know” (p. 293).
None.	8.0 Conclusion 8.1 Do you have any additional questions, concerns, or information you feel the researcher should know? Please provide your response in the space provided below.	• Hackos and Redish (1998) recommend thanking the user for their time (p. 269)and describing what feedback will be given as a result of the study (p. 201). • Hackos and Redish (1998) recommend, “As part of every interview, therefore, you should ask the user if there is anything else they think you should know” (p. 293).

Appendix K: Trace matrix for the focus group

This appendix provides the justification for the use of focus groups in this research. The justification is presented in three distinct steps; moving from broad to narrow. First, at the broadest level, the appendix provides general guidance regarding focus groups. Second, the scope is narrowed to other researchers who used focus groups in their CSF research. Third, and finally, the appendix provides a matrix that traces from the research questions to the focus group questions.

General Focus Group Guidance.

This section provides general guidance regarding focus groups. The information is presented in ascending order of publication date; i.e. from oldest to most recent.

- Hackos and Redish (1998) recommended,
    - A typical focus group includes 8 to 12 people plus facilitator. The facilitator follows, at least loosely, a script or plan that has been decided in advance… laying out the issues to be covered with the questions to be addressed. The facilitator make sure that no single person dominates a discussion, but the discussion stays close to the issues to be covered (that's the 'focus' part of a 'focus group'), and all the issues in the planner covered. Focus groups using the away from the worksite and last about two hours. (pp. 145–146)
- Creswell (2007) observed,
    - Focus groups are advantageous when the interaction among interviewees will likely yield the best information…. With this approach, however, care must be

taken to encourage all participants to talk and to monitor individuals who may dominate the conversation. (p. 133)

- When discussing the purpose in size of focus groups, Denzin and Lincoln (2008) noted, "At the broadest possible level, focus groups are collective conversations or group interviews. They can be small or large, directed one nondirected" (p. 375).
- Denzin and Lincoln (2008) observed that focus groups afford the researcher insights into group dynamics, or culture. They stated,
    - Among other things, the use of focus groups has allow scholars to move away from the dyad of the clinical interview and to explore group characteristics and dynamics is relevant constitutive forces in the construction of meaning in the practice of social life. Focus groups have also allowed researchers to explore the nature and effects of ongoing social discourse in ways that are not possible through individual interviews or observations. (p. 396)
- Focus groups can be used to access new kinds of information arising from interactional dynamics (Denzin & Lincoln, 2008, p. 396). They observed, "Focus groups are also invaluable for promoting among participants synergy that often leads to the unearthing of information that is so easy to reach an individual memory" (Denzin & Lincoln, 2008, p. 396). Further, Denzin and Lincoln (2008) claim, "'Real-world' problems cannot be solved by individuals alone; instead, they require rich and complex funds of communal knowledge and practice" (p. 397).

- Denzin and Lincoln (2008) noted,
    - … focus groups can be used strategically to inhibit the authority of researchers and to allow participants to 'take over' and 'own' the interview space…. And perhaps most important, the dialogic possibilities afforded by focus group helps researchers to work against premature consolidation of the understandings and explanations, thereby signaling the limits of reflexivity and the importance of intellectual/empirical modesty as forms of ethics and praxis. (2008, p. 396)

Focus Groups and CSF Research.

This section presents researchers who utilized focus groups during their CSF research. The information is presented in ascending order of publication date; i.e. from oldest to most recent.

- Rather than a second survey, a focus group could be used to afford managers and opportunity to review, and adjust, CSFs (Martin, 1982, p. 2).
- When reflecting on the value of the focusing workshop, Rockart and Crescenzi (1984) observed,
    - In the course of the focusing workshop, what had previously been implicit was made explicit – sometimes with surprising, and insightful results. In Jacque Huber's [vice president of sales] words: 'We all knew what was critical for our company, but the discussion – sharing and agreeing – was really important. What came out of it was a minor revelation. Seeing it on the blackboard in black and white is much more significant than carrying around a set of ideas which are merely intuitively felt.' (Rockart & Crescenzi, 1984, p. 8)

- Phase two began with a workshop aimed at defining a set of measures to be used to evaluate the CSFs from phase one (Rockart & Crescenzi, 1984, p. 9).
- The focus group approach is supported by the literature as Cooper (2009) also employed a focus group to verify the results of her CSF data collection and analysis (p. 20).

Tracing Research Questions to Focus Group Questions

This section provides a matrix that traces from the focus group question to the research question. The columns in the matrix are as follows:

1. **Research Question**: This column lists the research questions investigated by the focus group question.
2. **Focus Group Question**: This column lists the focus group question.

The flow is from focus group question (column 2) left to the research question (column 1). Accordingly, the matrix was sorted in ascending (column 2) focus group question order.

Research Question	🡐 Focus Group Question
None	Q-01: Do you have any questions regarding the objectives or structure of the focus group meeting?
None	Q-02: Do you have any questions regarding the research design?
None	Q-03: Do you have any questions regarding the online web-based survey?

Research Question	🡐 Focus Group Question
RQ3: What are the CSFs for global PLM IS implementation?	Q-04: Do you agree with the importance rating of the top five CSFs for this phase?
RQ3: What are the CSFs for global PLM IS implementation?	Q-05: What observations do you have regarding the data in Table 1?
RQ3: What are the CSFs for global PLM IS implementation?	P-01: [Table 1, Mean Order 2, Column DMS Global PLM CSF] What do you think contributed to the high importance rating and low standard deviation of Business Process Reengineering (Common Processes)?
RQ3: What are the CSFs for global PLM IS implementation?	P-02: [Table 1, Mean Order 4, Column DMS Global PLM CSF] This CSF, Global Integrated System, was the only CSF identified by DMS Global that was not in the academic literature. In other words, this CSF was unique to DMS Global. This CSF is similar in nature to Business Process Reengineering (Common Processes). Together these CSFs imply that a local PLM system with custom processes by location would be viewed as a failure. Do you agree with this assessment? Why, or why not?

Research Question	🡐 Focus Group Question
RQ3: What are the CSFs for global PLM IS implementation?	Q-06: Do you agree with the importance rating of the top five CSFs for this phase?
RQ3: What are the CSFs for global PLM IS implementation?	Q-07: What observations do you have regarding the data in Table 2?
RQ3: What are the CSFs for global PLM IS implementation?	P-03: [Table 2, Mean Order 2] Customer Satisfaction is new to the top five. In the previous phase, Customer Satisfaction was ranked 14 of 20; or in the bottom half. What do you think contributed to the significant jump in importance?
RQ3: What are the CSFs for global PLM IS implementation?	Q-08: Do you agree with the importance rating of the top five CSFs for this phase?
RQ3: What are the CSFs for global PLM IS implementation?	Q-09: What observations do you have regarding the data in Table 3?
RQ3: What are the CSFs for global PLM IS implementation?	Q-10: Do you agree with the importance rating of the top five CSFs for this phase?
RQ3: What are the CSFs for global PLM IS implementation?	Q-11: What observations do you have regarding the data in Table 4?
RQ3: What are the CSFs for global PLM IS implementation?	Q-12: Do you agree with the importance rating of the top five CSFs for this phase?

Research Question	← Focus Group Question
RQ3: What are the CSFs for global PLM IS implementation?	Q-13: What observations do you have regarding the data in Table 5?
RQ3: What are the CSFs for global PLM IS implementation?	P-04: [Table 5, Mean Order 5] At this phase in the project, the PLM system is ready to be implemented, or has been implemented, and the focus is on stabilizing the system post go-live. It appears to me it is now too late for testing. Why do you think testing remains in the top five?
RQ3: What are the CSFs for global PLM IS implementation?	Q-14: What observations do you have regarding the data in Table 6?
RQ3: What are the CSFs for global PLM IS implementation?	P-05: [Table 6, Column Heading 02 Blueprint Phase] It could be argued Project Preparation and Blueprint are the strategic phases of the project lifecycle as they define the vision of success, goals, and the design of the system. It follows then, that the top five CSF for these phases would be strategic in nature by the academic literature. When I consider the top five CSFs for these first two project phases, they do appear to be strategic

Research Question	← Focus Group Question
	in nature with the exception of Consultant/Systems Integrator. I believe the academic literature should have flagged these CSFs as strategic. What is your perspective?
RQ3: What are the CSFs for global PLM IS implementation?	P-06: [Table 5, Mean Order 5, Column 2] Top Management Support falls out of the top five after the Blueprint phase. The academic literature consistently had Top Management Support in the top five for all phases of the project lifecycle. Further, my professional experience is Top Management support remains critical during the Final Preparation Phase and Go Live & Support Phase because this is when the implementation of the new system moves from concept to reality causing fear, uncertainty, and doubt to increase. Accordingly, this is when top management support was instrumental in calming fears. What aspects of the DMS Global culture do you see that would

Research Question	← Focus Group Question
	discount the necessity for Top Management Support in later project phases?
RQ3: What are the CSFs for global PLM IS implementation?	Q-15: What observations do you have regarding the data in Table 7?
RQ3: What are the CSFs for global PLM IS implementation?	P-07: [Table 7, Line No 11, Column Recurrence] Project Management and Training have the highest recurrence across project phases among the top five CSFs. What insights does this give you to the psyche (mental and emotional state) of the project team who completed the survey?
RQ3: What are the CSFs for global PLM IS implementation?	P-08: [Table 7, Line No 14, Column DMS Global PLM CSFs] It appears to me that it is too late in the project cycle to consider User Satisfaction as a CSF. For example, if User Satisfaction was not considered during the Project Preparation phase (ranked 17 of 20) or the Blueprint Phase (ranked 14 of 20) then little can be done at Go Live & Support to provide for User Satisfaction. Do you feel changes should be made in the DMS Global

Research Question	🡐 Focus Group Question
	PLM project to ensure User Satisfaction is addressed earlier in the project lifecycle? If so, what changes do you recommend?
RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation? RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs?	Q-16: Would you have expected differences to be more pronounced in national or professional culture?
RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation? RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs?	Q-17: What observations do you have regarding the data in Table 8?
RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation? RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs?	P-09: [Table 8, Row 02, Column Project Phase] Why do you think there were no CSFs with statistically significant differences in the Blueprint Phase?

Research Question	🡐 Focus Group Question
RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation? RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs?	Q-18: Are you surprised by any of the CSFs with statistically significant differences in Table 9 or Figure 3?
RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation? RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs?	Q-19: Which CSFs with statistically significant differences in Table 9 or Figure 3 do you feel represent areas of potential conflict worthy of additional management care?
RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation? RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs?	Q-20: What do you feel are the root causes of the statistically significant differences for the CSFs in Table 9 or Figure 3?
RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation?	Q-21: What observations do you have regarding the data in Table 9 or Figure 3?

Research Question	← Focus Group Question
RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs?	
RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation? RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs?	P-10: [Table 9, Line No 4, and Line No 5] (*** omit if time short ***) As noted earlier, User Satisfaction is considered too late in the project lifecycle. Here we find statistically significant differences between the Japan and US assessment of importance. This indicates to me this CSF could become problematic. Do you agree? Why, or why not?
RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation? RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs?	P-11: [Table 9, Line No 1, and Line No 3] Of the CSFs with statistically significant difference, I would be most concerned with Top Management Support and Testing because they had mean rank 1 for the Project Preparation phase and Realization phase respectively. Do you agree? If so, what actions, if any, should be taken to mitigate this risk?

Research Question	🡐 Focus Group Question
RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation? RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs?	P-12: [Figure 3, General] When examining the data in Figure 3, Japan scored the mean importance consistently lower than the US, but had higher standard deviation for 3 of 5 CSFs. Do you have any insight into these results?
RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation? RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs?	Q-22: Are you surprised by any of the CSFs with statistically significant differences in Table 10 or Figure 4?
RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation? RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs?	Q-23: Which CSFs with statistically significant differences in Table 9 or Figure 4 do you feel represent areas of potential conflict worthy of additional management care?
RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation?	Q-24: What do you feel are the root causes of the statistically significant differences for the CSFs in Table 10 or Figure 4?

Research Question	← Focus Group Question
RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs?	
RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation? RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs?	Q-25: What observations do you have regarding the data in Table 10 or Figure 4?
RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation? RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs?	P-13: [Figure 4] Considering Figure 4, IT rated importance consistently lower than Engineering for 15 of 17 CSFs. What does this indicate about the culture of IT versus Engineering?
RQ4: How does culture change the relative importance of CSFs for global PLM IS implementation? RQ5: What theoretical framework emerges to integrate global PLM IS implementation, culture, and CSFs?	P-14: [Figure 4] Similarly, IT had larger standard deviation than Engineering for 16 of 17 CSFs indicating a wide range of opinion regarding the importance of the CSFs. What do you think are the causes of the variance in opinion among IT associates?

Research Question	← Focus Group Question
None	Q-26: Do you have any questions regarding the research results?
None	Q-27: Do you have any additional information that you feel would be helpful to this research?
None	P-15: [Conclusion General] Given the data and results presented in the Focus Group, are there any areas of this project you would approach differently? If so, please provide examples.

Appendix L: Chapter 3 methodology supplemental data

This appendix provides supplemental tables and figures referenced in chapter 3 methodology. This appendix is comprised of the following sections:

1. Survey – Codebook Detail
2. Survey – Descriptive Statics Detail
3. Survey – ANOVA Detail
4. Focus Group – Probing Questions Omitted Due to Time & Priority Constraints

Survey – codebook table.

Table 34 is the codebook developed to map the QuestionPro stage two data collection and analysis survey data to SPSS. Each row in the table represents a variable and has two, or more, lines. The first line in a row represents the default configuration of the variable in the extract from QuestionPro. The second line in a row represents the adjusted configuration (or transformation) of the variable in SPSS. For example, the third row of Table 34 has the following meaning:

- Name: the default name of "customer1" should be changed to "CultureNat".
- Type: the default type of "String" should be changed to "Numeric".
- Label: the default label of "Custom Variable 1" should be changed to "NationalCulture".
- Values: the default of no values should be changed to "1=Japan" and "2=US". This variable has footnote 1 which provide coding instructions found at the end of Table 34.
- Missing: the default of "None" implying no missing values requires no changes.

- Measure: the default measure of "Nominal" requires no changes

Table 34. Survey – QuestionPro Survey to SPSS Codebook

Name[a]	Type	Label	Values	Missing	Measure
responseID -	Numeric	Response ID	None	None	Nominal
ts -	String	Timestamp	None	None	Nominal
custom1 CultureNat	String Numeric	Custom Variable 1 NationalCulture	None* 1=Japan 2=US	None	Nominal
custom2 CulturePro	String Numeric	Custom Variable 2 ProfessionalCulture	None† 1=Engineer 2=Info Tech	None	Nominal
custom3 -	String	Custom Variable 3	None	None	Nominal
custom4 -	String	Custom Variable 4	None	None	Nominal
custom5 -	String	Custom Variable 5	None	None	Nominal
email -	String	Respondent Email	None	None	Nominal
timeTaken -	Numeric	Time Taken to Co…	None	None	Nominal
var9 Gender	Numeric	22 Please select… Gender	{1, Male}.	0	Nominal
var10 Age	Numeric	23 Please select… Age	{1, Under	0	Nominal Ordinal
var11 Education	Numeric	24 Please select… Education	{1, High S	0	Nominal Ordinal
var12 WorkYears	Numeric	25 Please select… TotalWorkYears	{1, Less t	0	Nominal Ordinal

Name[a]	Type	Label	Values	Missing	Measure
var14 DMSYears	Numeric	27 Please select… DMSWorkYears	{1, Less t	0	Nominal Ordinal
var15 ProjMonths	Numeric	28 Please select… DMSProjMonths	{1.0, Less	0	Nominal Ordinal
var16 ProjPhase	Numeric	29 Please select… DMSProjPhase	{1, Projec	0	Nominal
var27 CSFPPrep01	Numeric	1 Business Case… 01-01 BusinessCase	{1, No Imp	0 0,8	Nominal Scale
var28 CSFPPrep02	Numeric	2 Business Proce… 01-02 BPRCommonProcesses	{1, No Imp	0 0,8	Nominal Scale
var29 CSFPPrep03	Numeric	3 Change Managem… 01-03 ChangeMgmt	{1, No Imp	0 0,8	Nominal Scale
var30 CSFPPrep04	Numeric	4 Consultant Sys… 01-04 ConsultSysIntegrator	{1, No Imp	0 0,8	Nominal Scale
var31 CSFPPrep05	Numeric	5 Budget Cost Id… 01-05 BudgetCost	{1, No Imp	0 0,8	Nominal Scale
var32 CSFPPrep06	Numeric	6 Customer Satis… 01-06 CustSatisfaction	{1, No Imp	0 0,8	Nominal Scale
var33 CSFPPrep07	Numeric	7 Data Conversio… 01-07 DataConversion	{1, No Imp	0 0,8	Nominal Scale
var34 CSFPPrep08	Numeric	8 Global Integra… 01-08 GlobalIntegratedSys	{1, No Imp	0 0,8	Nominal Scale
var35 CSFPPrep09	Numeric	9 Goals and Obje… 01-09 GoalsObjectives	{1, No Imp	0 0,8	Nominal Scale
var36 CSFPPrep10	Numeric	10 Implementatio… 01-10 ImplementStrategy	{1, No Imp	0 0,8	Nominal Scale
var37 CSFPPrep11	Numeric	11 Past Experien… 01-11 PastExpLessonsLearn	{1, No Imp	0 0,8	Nominal Scale
var38 CSFPPrep12	Numeric	12 PLM System Ev… 01-12 PLMSysEvalSelect	{1, No Imp	0 0,8	Nominal Scale

Name[a]	Type	Label	Values	Missing	Measure
var39 CSFPPrep13	Numeric	13 Project Manag… 01-13 ProjMgmt	{1, No Imp	0 0,8	Nominal Scale
var40 CSFPPrep14	Numeric	14 Project Team… 01-14 ProjTeamResources	{1, No Imp	0 0,8	Nominal Scale
var41 CSFPPrep15	Numeric	15 Risk Manageme… 01-15 RiskMgmtQA	{1, No Imp	0 0,8	Nominal Scale
var42 CSFPPrep16	Numeric	16 Timeline Sche… 01-16 TimeSchedule	{1, No Imp	0 0,8	Nominal Scale
var43 CSFPPrep17	Numeric	17 Testing Creat… 01-17 Testing	{1, No Imp	0 0,8	Nominal Scale
var44 CSFPPrep18	Numeric	18 Top Managemen… 01-18 TopMgmtSupport	{1, No Imp	0 0,8	Nominal Scale
var45 CSFPPrep19	Numeric	19 Training Prov… 01-19 Training	{1, No Imp	0 0,8	Nominal Scale
var46 CSFPPrep20	Numeric	20 User Satisfac… 01-20 UserSatisfaction	{1, No Imp	0 0,8	Nominal Scale
var50 CSFBlue01	Numeric	1 Business Case… 02-01 BusinessCase	{1, No Imp	0 0,8	Nominal Scale
var51 CSFBlue02	Numeric	2 Business Proce… 02-02 BPRCommonProcesses	{1, No Imp	0 0,8	Nominal Scale
var52 CSFBlue03	Numeric	3 Change Managem… 02-03 ChangeMgmt	{1, No Imp	0 0,8	Nominal Scale
var53 CSFBlue04	Numeric	4 Consultant Sys… 02-04 ConsultSysIntegrator	{1, No Imp	0 0,8	Nominal Scale
var54 CSFBlue05	Numeric	5 Budget Cost Id… 02-05 BudgetCost	{1, No Imp	0 0,8	Nominal Scale
var55 CSFBlue06	Numeric	6 Customer Satis… 02-06 CustSatisfaction	{1, No Imp	0 0,8	Nominal Scale
var56 CSFBlue07	Numeric	7 Data Conversio… 02-07 DataConversion	{1, No Imp	0 0,8	Nominal Scale

Name[a]	Type	Label	Values	Missing	Measure
var57 CSFBlue08	Numeric	8 Global Integra… 02-08 GlobalIntegratedSys	{1, No Imp	0 0,8	Nominal Scale
var58 CSFBlue09	Numeric	9 Goals and Obje… 02-09 GoalsObjectives	{1, No Imp	0 0,8	Nominal Scale
var59 CSFBlue10	Numeric	10 Implementatio… 02-10 ImplementStrategy	{1, No Imp	0 0,8	Nominal Scale
var60 CSFBlue11	Numeric	11 Past Experien… 02-11 PastExpLessonsLearn	{1, No Imp	0 0,8	Nominal Scale
var61 CSFBlue12	Numeric	12 PLM System Ev… 02-12 PLMSysEvalSelect	{1, No Imp	0 0,8	Nominal Scale
var62 CSFBlue13	Numeric	13 Project Manag… 02-13 ProjMgmt	{1, No Imp	0 0,8	Nominal Scale
var63 CSFBlue14	Numeric	14 Project Team… 02-14 ProjTeamResources	{1, No Imp	0 0,8	Nominal Scale
var64 CSFBlue15	Numeric	15 Risk Manageme… 02-15 RiskMgmtQA	{1, No Imp	0 0,8	Nominal Scale
var65 CSFBlue16	Numeric	16 Timeline Sche… 02-16 TimeSchedule	{1, No Imp	0 0,8	Nominal Scale
var66 CSFBlue17	Numeric	17 Testing Creat… 02-17 Testing	{1, No Imp	0 0,8	Nominal Scale
var67 CSFBlue18	Numeric	18 Top Managemen… 02-18 TopMgmtSupport	{1, No Imp	0 0,8	Nominal Scale
var68 CSFBlue19	Numeric	19 Training Prov… 02-19 Training	{1, No Imp	0 0,8	Nominal Scale
var69 CSFBlue20	Numeric	20 User Satisfac… 02-20 UserSatisfaction	{1, No Imp	0 0,8	Nominal Scale
var73 CSFReal01	Numeric	1 Business Case… 03-01 BusinessCase	{1, No Imp	0 0,8	Nominal Scale
var74 CSFReal02	Numeric	2 Business Proce… 03-02 BPRCommonProcesses	{1, No Imp	0 0,8	Nominal Scale

Name[a]	Type	Label	Values	Missing	Measure
var75 CSFReal03	Numeric	3 Change Managem… 03-03 ChangeMgmt	{1, No Imp	0 0,8	Nominal Scale
var76 CSFReal04	Numeric	4 Consultant Sys… 03-04 ConsultSysIntegrator	{1, No Imp	0 0,8	Nominal Scale
var77 CSFReal05	Numeric	5 Budget Cost Id… 03-05 BudgetCost	{1, No Imp	0 0,8	Nominal Scale
var78 CSFReal06	Numeric	6 Customer Satis… 03-06 CustSatisfaction	{1, No Imp	0 0,8	Nominal Scale
var79 CSFReal07	Numeric	7 Data Conversio… 03-07 DataConversion	{1, No Imp	0 0,8	Nominal Scale
var80 CSFReal08	Numeric	8 Global Integra… 03-08 GlobalIntegratedSys	{1, No Imp	0 0,8	Nominal Scale
var81 CSFReal09	Numeric	9 Goals and Obje… 03-09 GoalsObjectives	{1, No Imp	0 0,8	Nominal Scale
var82 CSFReal10	Numeric	10 Implementatio… 03-10 ImplementStrategy	{1, No Imp	0 0,8	Nominal Scale
var83 CSFReal11	Numeric	11 Past Experien… 03-11 PastExpLessonsLearn	{1, No Imp	0 0,8	Nominal Scale
var84 CSFReal12	Numeric	12 PLM System Ev… 03-12 PLMSysEvalSelect	{1, No Imp	0 0,8	Nominal Scale
var85 CSFReal13	Numeric	13 Project Manag… 03-13 ProjMgmt	{1, No Imp	0 0,8	Nominal Scale
var86 CSFReal14	Numeric	14 Project Team… 03-14 ProjTeamResources	{1, No Imp	0 0,8	Nominal Scale
var87 CSFReal15	Numeric	15 Risk Manageme… 03-15 RiskMgmtQA	{1, No Imp	0 0,8	Nominal Scale
var88 CSFReal16	Numeric	16 Timeline Sche… 03-16 TimeSchedule	{1, No Imp	0 0,8	Nominal Scale
var89 CSFReal17	Numeric	17 Testing Creat… 03-17 Testing	{1, No Imp	0 0,8	Nominal Scale

Name[a]	Type	Label	Values	Missing	Measure
var90 CSFReal18	Numeric	18 Top Managemen… 03-18 TopMgmtSupport	{1, No Imp	0 0,8	Nominal Scale
var91 CSFReal19	Numeric	19 Training Prov… 03-19 Training	{1, No Imp	0 0,8	Nominal Scale
var92 CSFReal20	Numeric	20 User Satisfac… 03-20 UserSatisfaction	{1, No Imp	0 0,8	Nominal Scale
var96 CSFFPrep01	Numeric	1 Business Case… 04-01 BusinessCase	{1, No Imp	0 0,8	Nominal Scale
var97 CSFFPrep02	Numeric	2 Business Proce… 04-02 BPRCommonProcesses	{1, No Imp	0 0,8	Nominal Scale
var98 CSFFPrep03	Numeric	3 Change Managem… 04-03 ChangeMgmt	{1, No Imp	0 0,8	Nominal Scale
var99 CSFFPrep04	Numeric	4 Consultant Sys… 04-04 ConsultSysIntegrator	{1, No Imp	0 0,8	Nominal Scale
var100 CSFFPrep05	Numeric	5 Budget Cost Id… 04-05 BudgetCost	{1, No Imp	0 0,8	Nominal Scale
var101 CSFFPrep06	Numeric	6 Customer Satis.. 04-06 CustSatisfaction	{1, No Imp	0 0,8	Nominal Scale
var102 CSFFPrep07	Numeric	7 Data Conversio… 04-07 DataConversion	{1, No Imp	0 0,8	Nominal Scale
var103 CSFFPrep08	Numeric	8 Global Integra… 04-08 GlobalIntegratedSys	{1, No Imp	0 0,8	Nominal Scale
var104 CSFFPrep09	Numeric	9 Goals and Obje… 04-09 GoalsObjectives	{1, No Imp	0 0,8	Nominal Scale
var105 CSFFPrep10	Numeric	10 Implementatio… 04-10 ImplementStrategy	{1, No Imp	0 0,8	Nominal Scale
var106 CSFFPrep11	Numeric	11 Past Experien… 04-11 PastExpLessonsLearn	{1, No Imp	0 0,8	Nominal Scale
var107 CSFFPrep12	Numeric	12 PLM System Ev… 04-12 PLMSysEvalSelect	{1, No Imp	0 0,8	Nominal Scale

Name[a]	Type	Label	Values	Missing	Measure
var108 CSFFPrep13	Numeric	13 Project Manag… 04-13 ProjMgmt	{1, No Imp	0 0,8	Nominal Scale
var109 CSFFPrep14	Numeric	14 Project Team… 04-14 ProjTeamResources	{1, No Imp	0 0,8	Nominal Scale
var110 CSFFPrep15	Numeric	15 Risk Manageme… 04-15 RiskMgmtQA	{1, No Imp	0 0,8	Nominal Scale
var111 CSFFPrep16	Numeric	16 Timeline Sche… 04-16 TimeSchedule	{1, No Imp	0 0,8	Nominal Scale
var112 CSFFPrep17	Numeric	17 Testing Creat… 04-17 Testing	{1, No Imp	0 0,8	Nominal Scale
var113 CSFFPrep18	Numeric	18 Top Managemen… 04-18 TopMgmtSupport	{1, No Imp	0 0,8	Nominal Scale
var114 CSFFPrep19	Numeric	19 Training Prov… 04-19 Training	{1, No Imp	0 0,8	Nominal Scale
var115 CSFFPrep20	Numeric	20 User Satisfac… 04-20 UserSatisfaction	{1, No Imp	0 0,8	Nominal Scale
var119 CSFGoLiv01	Numeric	1 Business Case… 05-01 BusinessCase	{1, No Imp	0 0,8	Nominal Scale
var120 CSFGoLiv02	Numeric	2 Business Proce… 05-02 BPRCommonProcesses	{1, No Imp	0 0,8	Nominal Scale
var121 CSFGoLiv03	Numeric	3 Change Managem… 05-03 ChangeMgmt	{1, No Imp	0 0,8	Nominal Scale
var122 CSFGoLiv04	Numeric	4 Consultant Sys… 05-04 ConsultSysIntegrator	{1, No Imp	0 0,8	Nominal Scale
var123 CSFGoLiv05	Numeric	5 Budget Cost Id… 05-05 BudgetCost	{1, No Imp	0 0,8	Nominal Scale
var124 CSFGoLiv06	Numeric	6 Customer Satis… 05-06 CustSatisfaction	{1, No Imp	0 0,8	Nominal Scale
var125 CSFGoLiv07	Numeric	7 Data Conversio… 05-07 DataConversion	{1, No Imp	0 0,8	Nominal Scale

Name[a]	Type	Label	Values	Missing	Measure
var126 CSFGoLiv08	Numeric	8 Global Integra… 05-08 GlobalIntegratedSys	{1, No Imp	0 0,8	Nominal Scale
var127 CSFGoLiv09	Numeric	9 Goals and Obje… 05-09 GoalsObjectives	{1, No Imp	0 0,8	Nominal Scale
var128 CSFGoLiv10	Numeric	10 Implementatio… 05-10 ImplementStrategy	{1, No Imp	0 0,8	Nominal Scale
var129 CSFGoLiv11	Numeric	11 Past Experien… 05-11 PastExpLessonsLearn	{1, No Imp	0 0,8	Nominal Scale
var130 CSFGoLiv12	Numeric	12 PLM System Ev… 05-12 PLMSysEvalSelect	{1, No Imp	0 0,8	Nominal Scale
var131 CSFGoLiv13	Numeric	13 Project Manag… 05-13 ProjMgmt	{1, No Imp	0 0,8	Nominal Scale
var132 CSFGoLiv14	Numeric	14 Project Team… 05-14 ProjTeamResources	{1, No Imp	0 0,8	Nominal Scale
var133 CSFGoLiv15	Numeric	15 Risk Manageme… 05-15 RiskMgmtQA	{1, No Imp	0 0,8	Nominal Scale
var134 CSFGoLiv16	Numeric	16 Timeline Sche… 05-16 TimeSchedule	{1, No Imp	0 0,8	Nominal Scale
var135 CSFGoLiv17	Numeric	17 Testing Creat… 05-17 Testing	{1, No Imp	0 0,8	Nominal Scale
var136 CSFGoLiv18	Numeric	18 Top Managemen… 05-18 TopMgmtSupport	{1, No Imp	0 0,8	Nominal Scale
var137 CSFGoLiv19	Numeric	19 Training Prov… 05-19 Training	{1, No Imp	0 0,8	Nominal Scale
var138 CSFGoLiv20	Numeric	20 User Satisfac… 05-20 UserSatisfaction	{1, No Imp	0 0,8	Nominal Scale
var143 Innovate01	Numeric	61 Technical inn… 01 TechInnovateAccept	{1, Strong	0 0,6	Nominal Scale
var144 Innovate02	Numeric	62 Management ac… 02 MgmtSeekInnovate	{1, Strong	0 0,6	Nominal Scale

Name[a]	Type	Label	Values	Missing	Measure
var145 Innovate03	Numeric	63 Innovation is… 03 ProgProjInnovateAccept	{1, Strong	0 0,6	Nominal Scale
var146 Innovate04	Numeric	64 People are pe… 04 PenalizedIdeasNotWork	{1, Strong	0 0,6	Nominal Scale
var147 Innovate05	Numeric	65 Innovation in… 05 InnovateDMSGlobalRisky	{1, Strong	0 0,6	Nominal Scale

Note. [a]The presence of "-" indicates the variable name was not changed from QuestionPro to SPSS. * National Culture shall be set equal to birth country. † Professional Culture shall be set equal to the functional job defined by the DMS Global PLM project organizational chart.

Survey – descriptive statics table.

Table 35 contains the details of the descriptive statistics I generated for the stage two data collection and analysis survey data.

Table 35. Survey – Descriptive Statics Detail

Data Set	Frequency Variables	Statistics	Output
Demographic Data	CultureNat, CulturePro, Gender, Age, Education, WorkYears, DMSYears, ProjMonths, ProjPhase	STDDEV, VARIANCE, RANGE, MINIMUM, MAXIMUM, MEAN, MEDIAN, MODE, SUM	PIECHART, BARCHART, HISTOGRAM
CSFs	CSFPPrep01, CSFPPrep02, CSFPPrep03, CSFPPrep04, CSFPPrep05, CSFPPrep06, CSFPPrep07, CSFPPrep08, CSFPPrep09, CSFPPrep10, CSFPPrep11, CSFPPrep12, CSFPPrep13, CSFPPrep14, CSFPPrep15, CSFPPrep16, CSFPPrep17, CSFPPrep18, CSFPPrep19, CSFPPrep20, CSFBlue01, CSFBlue02, CSFBlue03, CSFBlue04, CSFBlue05, CSFBlue06, CSFBlue07, CSFBlue08, CSFBlue09, CSFBlue10, CSFBlue11, CSFBlue12, CSFBlue13, CSFBlue14, CSFBlue15, CSFBlue16, CSFBlue17, CSFBlue18, CSFBlue19, CSFBlue20, CSFReal01, CSFReal02, CSFReal03, CSFReal04, CSFReal05, CSFReal06, CSFReal07, CSFReal08, CSFReal09, CSFReal10, CSFReal11, CSFReal12, CSFReal13, CSFReal14, CSFReal15, CSFReal16, CSFReal17, CSFReal18, CSFReal19, CSFReal20, CSFFPrep01, CSFFPrep02, CSFFPrep03, CSFFPrep04, CSFFPrep05, CSFFPrep06, CSFFPrep07, CSFFPrep08, CSFFPrep09, CSFFPrep10, CSFFPrep11, CSFFPrep12, CSFFPrep13, CSFFPrep14, CSFFPrep15,	STDDEV, VARIANCE, RANGE, MINIMUM, MAXIMUM, MEAN, MEDIAN, MODE, SUM	PIECHART, BARCHART, HISTOGRAM

Data Set	Frequency Variables	Statistics	Output
	CSFFPrep16, CSFFPrep17, CSFFPrep18, CSFFPrep19, CSFFPrep20, CSFGoLiv01, CSFGoLiv02, CSFGoLiv03, CSFGoLiv04, CSFGoLiv05, CSFGoLiv06, CSFGoLiv07, CSFGoLiv08, CSFGoLiv09, CSFGoLiv10, CSFGoLiv11, CSFGoLiv12, CSFGoLiv13, CSFGoLiv14, CSFGoLiv15, CSFGoLiv16, CSFGoLiv17, CSFGoLiv18, CSFGoLiv19, CSFGoLiv20		
Innovation	Innovate01, Innovate02, Innovate03, Innovate04, Innovate05	STDDEV, VARIANCE, RANGE, MINIMUM, MAXIMUM, MEAN, MEDIAN, MODE, SUM	PIECHART, BARCHART, HISTOGRAM

Survey – ANOVA table.

Table 36 contains the details of the analysis of variance (ANOVA) for the survey data.

Table 36. Survey – ANOVA Details

Data Set	Dependent Variables	Independent Variable
Project Preparation Phase CSFs by National Culture	CSFPPrep01, CSFPPrep02, CSFPPrep03, CSFPPrep04, CSFPPrep05, CSFPPrep06, CSFPPrep07, CSFPPrep08, CSFPPrep09, CSFPPrep10, CSFPPrep11, CSFPPrep12, CSFPPrep13, CSFPPrep14, CSFPPrep15, CSFPPrep16, CSFPPrep17, CSFPPrep18, CSFPPrep19, CSFPPrep20	CultureNat
Project Preparation Phase CSFs by Professional Culture	CSFPPrep01, CSFPPrep02, CSFPPrep03, CSFPPrep04, CSFPPrep05, CSFPPrep06, CSFPPrep07, CSFPPrep08, CSFPPrep09, CSFPPrep10, CSFPPrep11, CSFPPrep12, CSFPPrep13, CSFPPrep14, CSFPPrep15, CSFPPrep16, CSFPPrep17, CSFPPrep18, CSFPPrep19, CSFPPrep20	CulturePro
Blueprint Phase CSFs by National Culture	CSFBlue01, CSFBlue02, CSFBlue03, CSFBlue04, CSFBlue05, CSFBlue06, CSFBlue07, CSFBlue08, CSFBlue09, CSFBlue10, CSFBlue11, CSFBlue12, CSFBlue13, CSFBlue14, CSFBlue15, CSFBlue16, CSFBlue17, CSFBlue18, CSFBlue19, CSFBlue20	CultureNat
Blueprint Phase CSFs by Professional Culture	CSFBlue01, CSFBlue02, CSFBlue03, CSFBlue04, CSFBlue05, CSFBlue06, CSFBlue07, CSFBlue08, CSFBlue09, CSFBlue10, CSFBlue11, CSFBlue12, CSFBlue13, CSFBlue14, CSFBlue15, CSFBlue16, CSFBlue17, CSFBlue18, CSFBlue19, CSFBlue20	CulturePro

Realization Phase CSFs by National Culture	CSFReal01, CSFReal02, CSFReal03, CSFReal04, CSFReal05, CSFReal06, CSFReal07, CSFReal08, CSFReal09, CSFReal10, CSFReal11, CSFReal12, CSFReal13, CSFReal14, CSFReal15, CSFReal16, CSFReal17, CSFReal18, CSFReal19, CSFReal20	CultureNat
Realization Phase CSFs by Professional Culture	CSFReal01, CSFReal02, CSFReal03, CSFReal04, CSFReal05, CSFReal06, CSFReal07, CSFReal08, CSFReal09, CSFReal10, CSFReal11, CSFReal12, CSFReal13, CSFReal14, CSFReal15, CSFReal16, CSFReal17, CSFReal18, CSFReal19, CSFReal20	CulturePro
Final Preparation Phase CSFs by National Culture	CSFFPrep01, CSFFPrep02, CSFFPrep03, CSFFPrep04, CSFFPrep05, CSFFPrep06, CSFFPrep07, CSFFPrep08, CSFFPrep09, CSFFPrep10, CSFFPrep11, CSFFPrep12, CSFFPrep13, CSFFPrep14, CSFFPrep15, CSFFPrep16, CSFFPrep17, CSFFPrep18, CSFFPrep19, CSFFPrep20	CultureNat
Final Preparation Phase CSFs by Professional Culture	CSFFPrep01, CSFFPrep02, CSFFPrep03, CSFFPrep04, CSFFPrep05, CSFFPrep06, CSFFPrep07, CSFFPrep08, CSFFPrep09, CSFFPrep10, CSFFPrep11, CSFFPrep12, CSFFPrep13, CSFFPrep14, CSFFPrep15, CSFFPrep16, CSFFPrep17, CSFFPrep18, CSFFPrep19, CSFFPrep20	CulturePro
Go Live & Support Phase CSFs by National Culture	CSFGoLiv01, CSFGoLiv02, CSFGoLiv03, CSFGoLiv04, CSFGoLiv05, CSFGoLiv06, CSFGoLiv07, CSFGoLiv08, CSFGoLiv09, CSFGoLiv10, CSFGoLiv11, CSFGoLiv12, CSFGoLiv13, CSFGoLiv14, CSFGoLiv15, CSFGoLiv16, CSFGoLiv17, CSFGoLiv18, CSFGoLiv19, CSFGoLiv20	CultureNat

Go Live & Support Phase CSFs by Professional Culture	CSFGoLiv01, CSFGoLiv02, CSFGoLiv03, CSFGoLiv04, CSFGoLiv05, CSFGoLiv06, CSFGoLiv07, CSFGoLiv08, CSFGoLiv09, CSFGoLiv10, CSFGoLiv11, CSFGoLiv12, CSFGoLiv13, CSFGoLiv14, CSFGoLiv15, CSFGoLiv16, CSFGoLiv17, CSFGoLiv18, CSFGoLiv19, CSFGoLiv20	CulturePro

Focus group – probing questions omitted due to constraints.

The following four probing questions were skipped because participant feedback (e.g. glancing at watches, turning to the next page of the protocol) indicated they desired to move forward:

- P-02: [Table 1, Mean Order 4, Column DMS Global PLM CSF] This CSF, Global Integrated System, was the only CSF identified by DMS Global that was not in the academic literature. In other words, this CSF was unique to DMS Global. This CSF is similar in nature to Business Process Reengineering (Common Processes). Together these CSFs imply that a local PLM system with custom processes by location would be viewed as a failure. Do you agree with this assessment? Why, or why not?
- P-04: [Table 5, Mean Order 5] At this phase in the project, the PLM system is ready to be implemented, or has been implemented, and the focus is on stabilizing the system post go-live. It appears to me it is now too late for testing. Why do you think testing remains in the top five?
- P-05: [Table 6, Column Heading 02 Blueprint Phase] It could be argued Project Preparation and Blueprint are the strategic phases of the project lifecycle as they define the vision of success, goals, and the design of the system. It follows then, that the top five CSF for these phases would be strategic in nature by the academic literature. When I consider the top five CSFs for these first two project phases, they do appear to be strategic in nature with the exception of Consultant/Systems

Integrator. I believe the academic literature should have flagged these CSFs as strategic. What is your perspective?

- P-10: [Table 9, Line No 4, and Line No 5] As noted earlier, User Satisfaction is considered too late in the project lifecycle. Here we find statistically significant differences between the Japanese and US assessment of importance. This indicates to me this CSF could become problematic. Do you agree? Why, or why not?

Appendix M: Chapter 4 results supplemental data

This appendix provides supplemental tables and figures referenced in chapter 4 results.

This appendix is comprised of the following sections:

1. In-Depth Interview – Participant Demographic Graphs
2. Survey – Aggregate Culture – CSFs – All 20 by Project Phase
3. Survey – Participant Demographic Graphs
4. Survey – National Culture – CSFs – Top Five & Significant ANOVA Graphs
5. Survey – Professional Culture – CSFs – Top Five & Significant ANOVA Graphs

In-depth interview – participant demographic graphs.

Figure 20 through Figure 29 display the in-depth interview participant demographics.

There were ten demographic questions in the in-depth interview protocol (Appendix E).

1. Please tell me the country in which you were born.

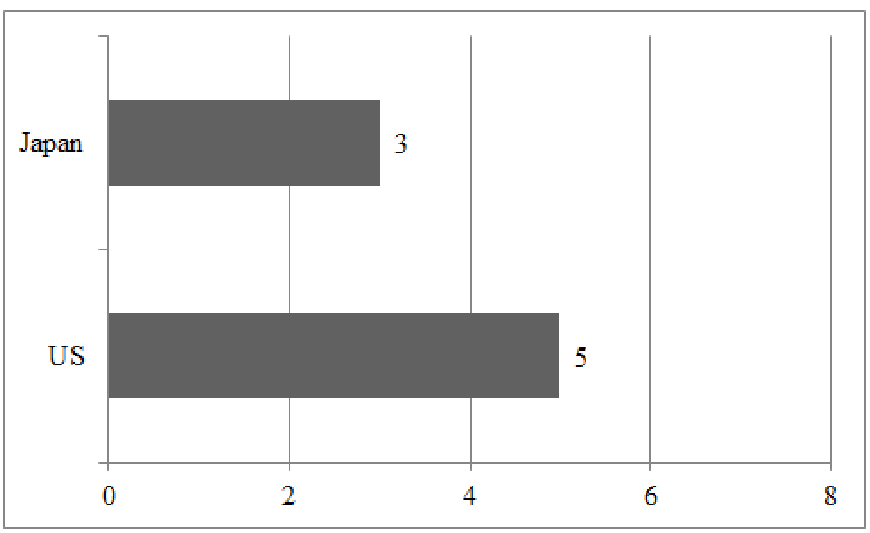

Figure 20. In-Depth Interview – Participant Country of Birth

2. Please select the one most appropriate answer from the following list that best describes your current age.

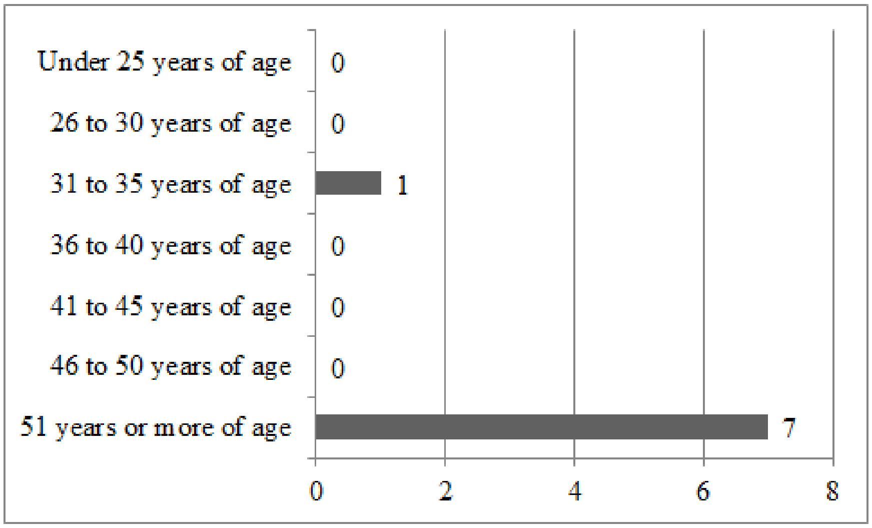

Figure 21. In-Depth Interview – Participant Current Age

3. Please select the one most appropriate answer from the following list that best describes your highest level of education.

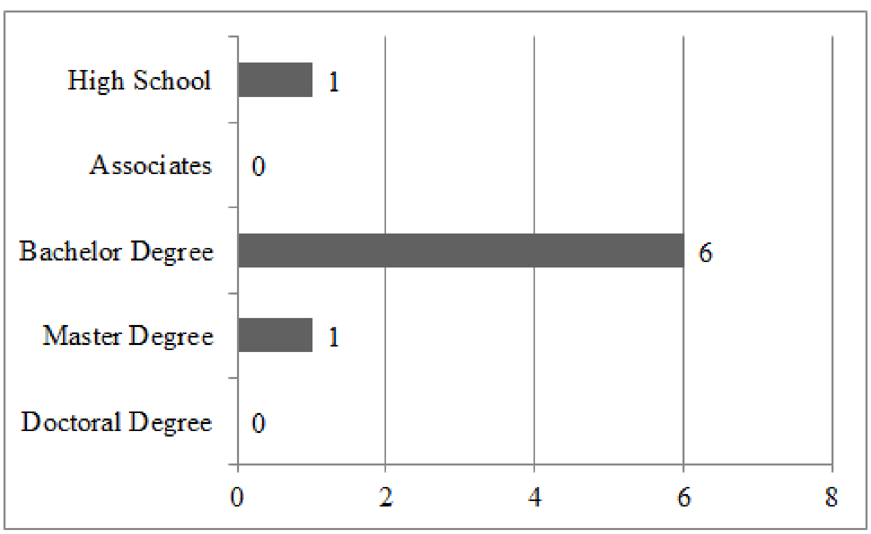

Figure 22. In-Depth Interview – Participant Highest Level of Education

4. Please describe your major, or area of study, for your higher education. If you have more than one major, or area of study, then please describe.

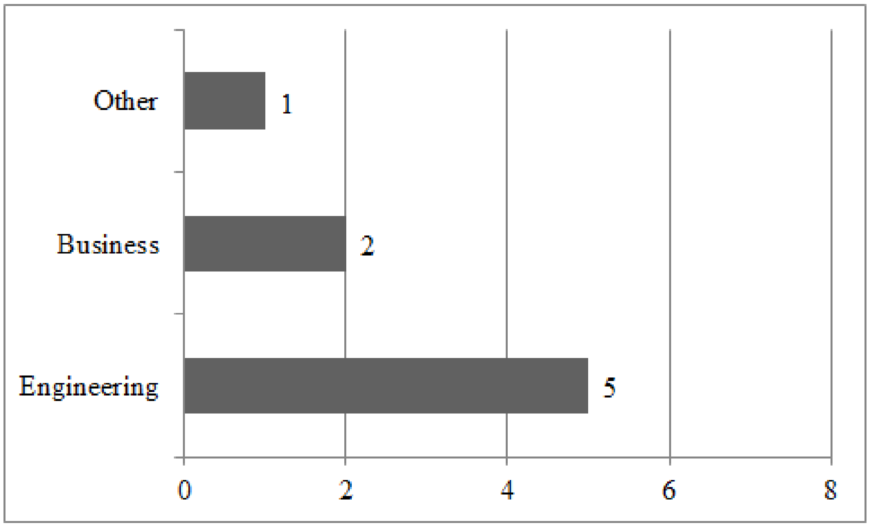

Figure 23. In-Depth Interview – Participant Highest Level of Education Major

5. Please select the one most appropriate answer from the following list that best describes your total number of years of work experience.

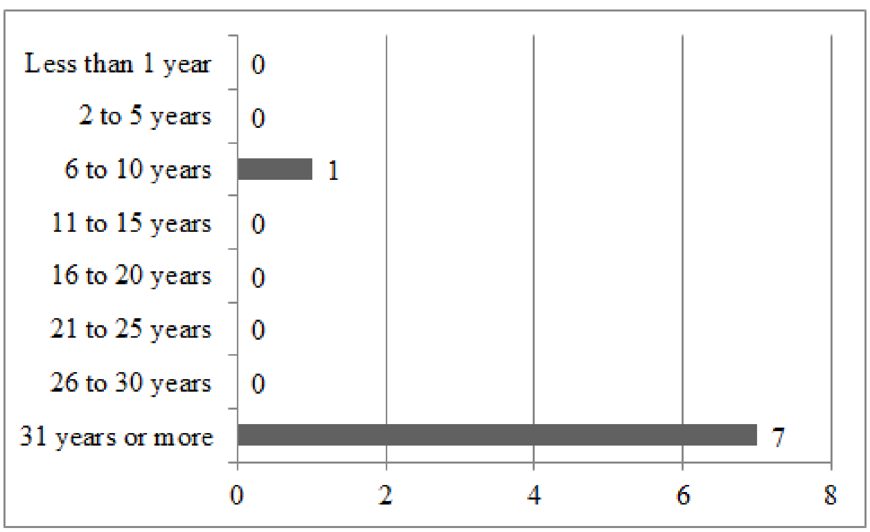

Figure 24. In-Depth Interview – Participant Total Years of Work Experience

6. Please tell me your current job title in DMS Global.

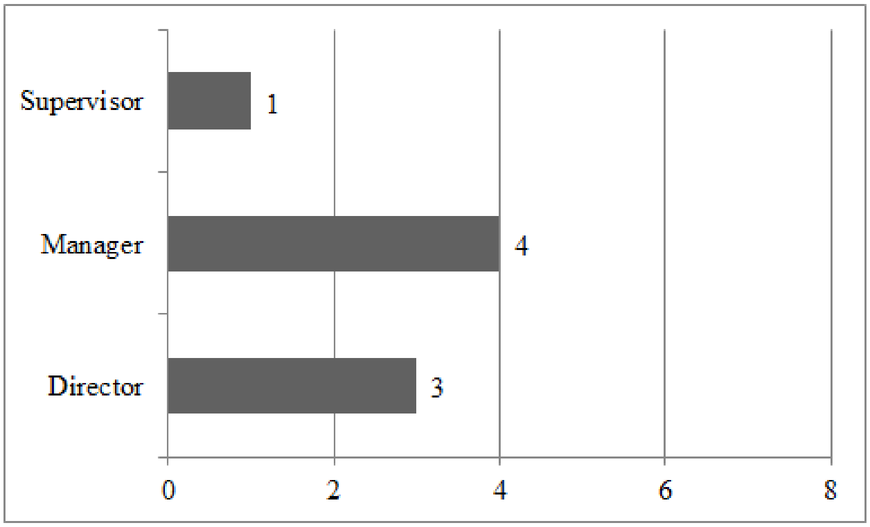

Figure 25. In-Depth Interview – Participant Current Job Title at DMS Global

7. Please select the one most appropriate answer from the following list that best describes the number of years you have worked for DMS Global.

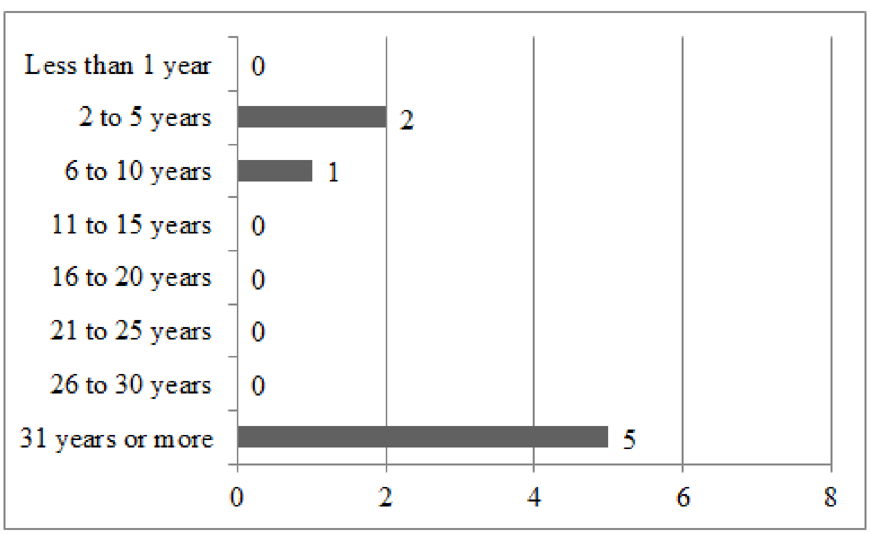

Figure 26. In-Depth Interview – Participant Total Years Worked for DMS Global

8. Please select the one most appropriate answer from the following list that best describes the total amount of time you have been involved in the DMS Global PLM project.

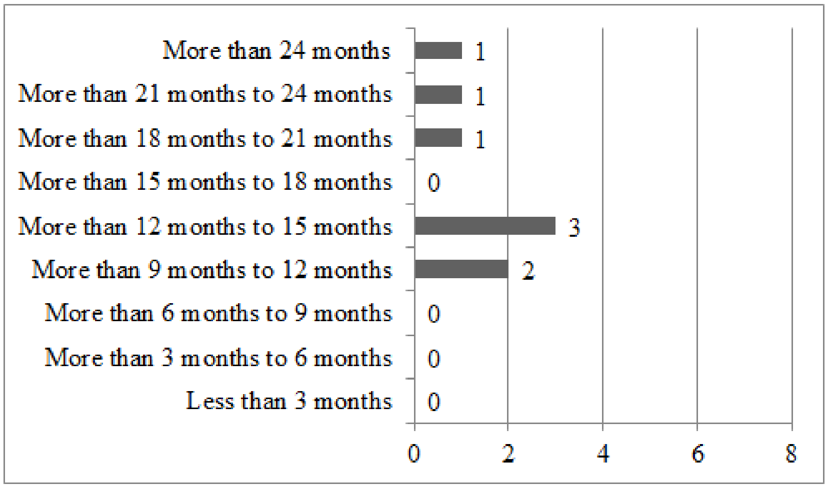

Figure 27. In-Depth Interview – Participant Total Time Involved with PLM Project

9. Please select the one most appropriate answer from the following list that describes the current phase of your PLM project.

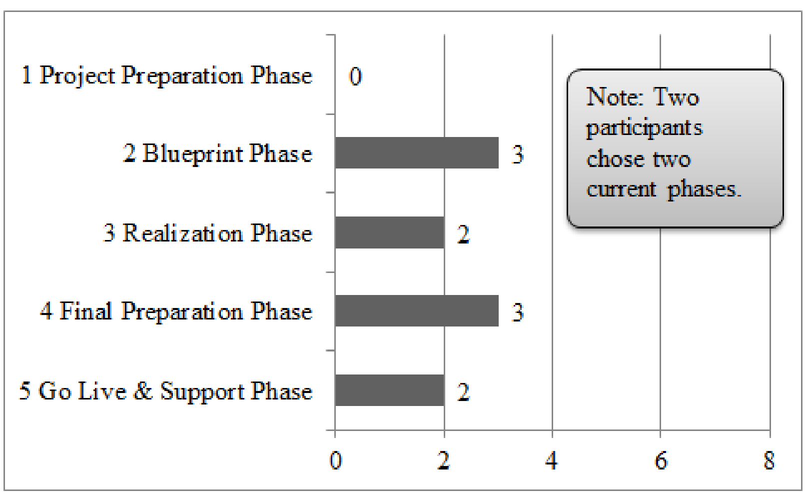

Figure 28. In-Depth Interview – Participant Current PLM Project Phase

10. If you have been involved in past information system implementation projects, then please briefly describe the projects and your role.

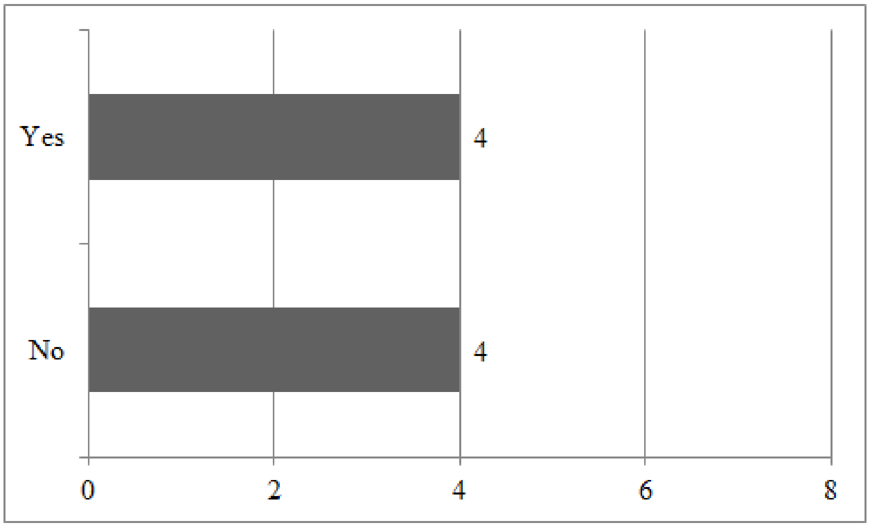

Figure 29. In-Depth Interview – Participant past Project Experience

Survey – aggregate culture – CSFs – all 20 by project phase.

Table 37 contains the aggregate culture mean importance for all 20 CSFs by project phase from the stage two survey. The table is sorted by Project Phase, Rank, and CSF

Table 37. Survey – Aggregate Culture – CSFs All 20 by Project Phase

R	CSF†	n	M	SD	Min	Max
	P1 Project Preparation Phase					
1	P1-18 **TopMgmtSupport(S)**	20	6.00	0.973	4	7
2	P1-02 BPRCommonProcesses	20	5.90	0.968	4	7
3	P1-01 **BusinessCase(S)**	20	5.80	0.951	4	7
3	P1-08 GlobalIntegratedSys	20	5.80	1.056	4	7
5	P1-04 ConsultSysIntegrator	20	5.65	1.268	3	7
6	P1-03 **ChangeMgmt(S)**	20	5.60	1.095	3	7
6	P1-12 PLMSysEvalSelect	20	5.60	1.046	4	7
8	P1-14 ProjTeamResources	20	5.55	0.999	4	7
9	P1-09 **GoalsObjectives(S)**	20	5.50	1.000	4	7
10	P1-07 DataConversion	20	5.45	1.538	2	7
11	P1-05 BudgetCost	20	5.35	1.182	3	7
11	P1-11 PastExpLessonsLearn	20	5.35	1.137	3	7
11	P1-19 Training	20	5.35	1.694	1	7
14	P1-06 CustSatisfaction	20	5.25	1.517	2	7
15	P1-13 **ProjMgmt(S)**	20	5.20	1.005	3	7
16	P1-10 **ImplementStrategy(S)**	20	5.15	1.089	2	7
16	P1-20 UserSatisfaction	20	5.15	1.496	1	7
18	P1-16 TimeSchedule	20	5.05	1.317	2	7
19	P1-17 Testing	20	4.95	1.669	1	7
20	P1-15 RiskMgmtQA	20	4.80	1.005	3	6
	P2 Blueprint Phase					
1	P2-02 BPRCommonProcesses	16	6.00	0.894	4	7
2	P2-06 CustSatisfaction	16	5.56	1.153	3	7
3	**P2-03 ChangeMgmt(S)**	16	5.50	1.095	3	7
4	P2-04 ConsultSysIntegrator	16	5.44	1.459	1	7
4	**P2-18 TopMgmtSupport(S)**	16	5.44	1.590	1	7
6	P2-07 DataConversion	16	5.31	1.662	1	7
6	P2-14 ProjTeamResources	16	5.31	1.448	1	7
8	P2-05 BudgetCost	16	5.25	1.483	1	7
9	P2-11 PastExpLessonsLearn	16	5.19	1.109	4	7
10	**P2-13 ProjMgmt(S)**	16	5.06	0.998	3	6

R	CSF†	n	M	SD	Min	Max
10	P2-15 RiskMgmtQA	16	5.06	0.998	4	7
12	**P2-01 BusinessCase(S)**	16	5.00	1.932	1	7
12	P2-16 TimeSchedule	16	5.00	1.414	1	7
12	P2-20 UserSatisfaction	16	5.00	1.155	2	6
15	**P2-10 ImplementStrategy(S)**	16	4.94	1.436	1	6
15	P2-12 PLMSysEvalSelect	16	4.94	1.482	1	7
15	P2-17 Testing	16	4.94	1.731	1	7
18	**P2-09 GoalsObjectives(S)**	16	4.81	1.377	1	7
19	P2-08 GlobalIntegratedSys	16	4.69	1.702	1	7
20	P2-19 Training	16	4.38	2.029	1	7
	P3 Realization Phase					
1	P3-17 Testing	19	5.79	1.437	2	7
2	P3-13 **ProjMgmt(S)**	19	5.53	0.905	4	7
3	P3-19 Training	19	5.47	1.577	2	7
4	P3-15 RiskMgmtQA	19	5.42	1.121	4	7
5	P3-06 CustSatisfaction	19	5.37	1.212	3	7
5	P3-07 DataConversion	19	5.37	1.422	2	7
5	P3-16 TimeSchedule	19	5.37	1.535	1	7
8	P3-14 ProjTeamResources	19	5.32	1.529	1	7
9	P3-09 **GoalsObjectives(S)**	19	5.26	1.240	1	6
10	P3-02 BPRCommonProcesses	19	5.21	1.084	3	7
10	P3-04 ConsultSysIntegrator	19	5.21	1.548	1	7
10	P3-10 **ImplementStrategy(S)**	19	5.21	1.316	1	7
10	P3-18 **TopMgmtSupport(S)**	19	5.21	1.813	1	7
10	P3-20 UserSatisfaction	19	5.21	1.228	2	7
15	P3-11 PastExpLessonsLearn	19	5.16	1.772	1	7
16	P3-08 GlobalIntegratedSys	19	5.11	1.524	1	7
17	P3-03 **ChangeMgmt(S)**	19	4.89	1.663	1	7
17	P3-05 BudgetCost	19	4.89	1.487	1	7
19	P3-12 PLMSysEvalSelect	19	4.63	1.862	1	7
20	P3-01 **BusinessCase(S)**	19	4.26	1.968	1	7
	P4 Final Preparation Phase					
1	P4-13 **ProjMgmt(S)**	19	5.84	0.834	4	7
2	P4-19 Training	19	5.79	1.084	3	7
3	P4-07 DataConversion	19	5.68	1.108	4	7
4	P4-15 RiskMgmtQA	19	5.47	1.020	4	7
4	P4-16 TimeSchedule	19	5.47	1.679	1	7
4	P4-17 Testing	19	5.47	1.504	2	7
7	P4-06 CustSatisfaction	19	5.37	1.461	2	7

R	CSF[†]	n	M	SD	Min	Max
7	P4-20 UserSatisfaction	19	5.37	1.422	2	7
9	P4-14 ProjTeamResources	19	5.32	1.635	1	7
10	P4-18 **TopMgmtSupport(S)**	19	5.21	1.686	1	7
11	P4-05 BudgetCost	19	5.05	1.682	1	7
12	P4-08 GlobalIntegratedSys	19	5.00	1.700	1	7
13	P4-03 **ChangeMgmt(S)**	19	4.95	1.508	1	7
14	P4-04 ConsultSysIntegrator	19	4.89	1.792	1	7
14	P4-10 **ImplementStrategy(S)**	19	4.89	1.449	1	6
14	P4-11 PastExpLessonsLearn	19	4.89	1.595	1	7
17	P4-09 **GoalsObjectives(S)**	19	4.84	1.500	1	7
18	P4-02 BPRCommonProcesses	19	4.68	1.734	1	7
19	P4-12 PLMSysEvalSelect	19	4.42	1.981	1	7
20	P4-01 **BusinessCase(S)**	19	4.16	2.007	1	7
	P5. Go Live & Support Phase					
1	P5-19 Training	19	5.84	1.119	3	7
2	P5-13 **ProjMgmt(S)**	19	5.53	1.219	2	7
3	P5-20 UserSatisfaction	19	5.47	1.504	1	7
4	P5-07 DataConversion	19	5.37	1.257	3	7
5	P5-17 Testing	19	5.26	1.759	1	7
6	P5-16 TimeSchedule	19	5.21	1.782	1	7
7	P5-06 CustSatisfaction	19	5.16	1.608	1	7
7	P5-08 GlobalIntegratedSys	19	5.16	1.573	1	7
9	P5-14 ProjTeamResources	19	5.11	1.761	1	7
10	P5-11 PastExpLessonsLearn	19	5.05	1.985	1	7
11	P5-03 **ChangeMgmt(S)**	19	5.00	1.563	1	7
11	P5-15 RiskMgmtQA	19	5.00	1.155	2	6
13	P5-18 **TopMgmtSupport(S)**	19	4.95	1.810	1	7
14	P5-04 ConsultSysIntegrator	19	4.68	1.887	1	7
15	P5-05 BudgetCost	19	4.63	1.978	1	7
15	P5-10 **ImplementStrategy(S)**	19	4.63	1.802	1	7
17	P5-09 **GoalsObjectives(S)**	19	4.58	1.610	1	7
18	P5-02 BPRCommonProcesses	19	4.53	2.118	1	7
19	P5-12 PLMSysEvalSelect	19	4.42	2.090	1	7
20	P5-01 **BusinessCase(S)**	19	4.26	2.104	1	7

Note. R = rank. [†]CSFs in bold text followed by "(S)" are strategic in nature (Finney & Corbett, 2007, p. 335; Holland & Light, 1999, p. 31).

Survey – participant demographics graphs.

Figure 30 through Figure 39 display the survey participant demographics. There were ten demographic questions in the survey protocol (Appendix F).

1. Please tell me the country in which you were born in the space below.

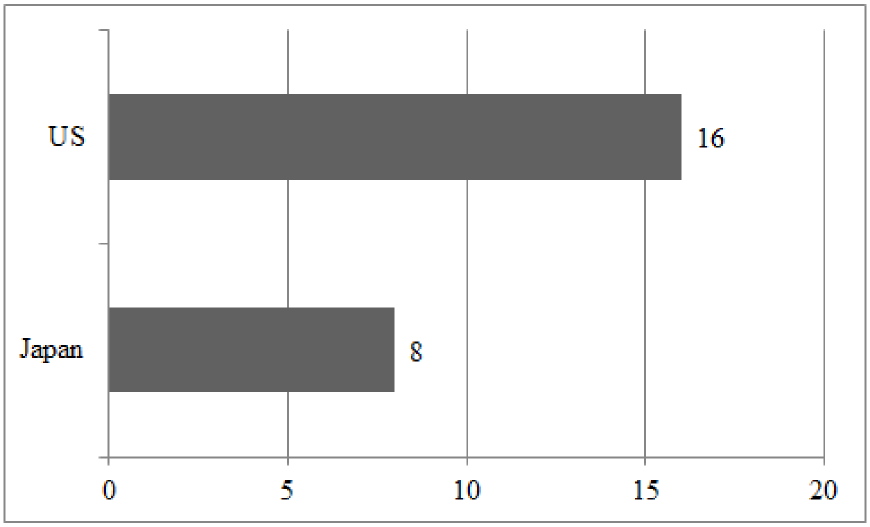

Figure 30. Survey – Participant Country of Birth

2. Please select the one most appropriate answer from the following list that best describes your gender.

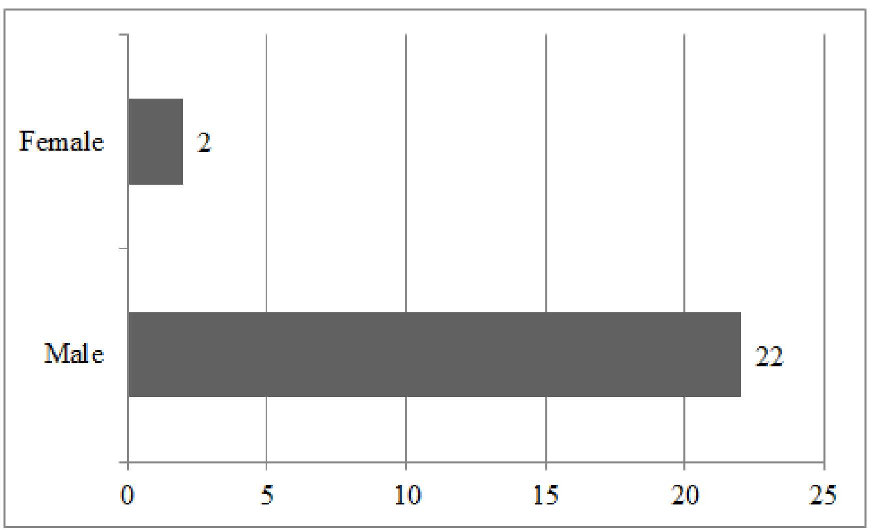

Figure 31. Survey – Participant Gender

3. Please select the one most appropriate answer from the following list that best describes your current age.

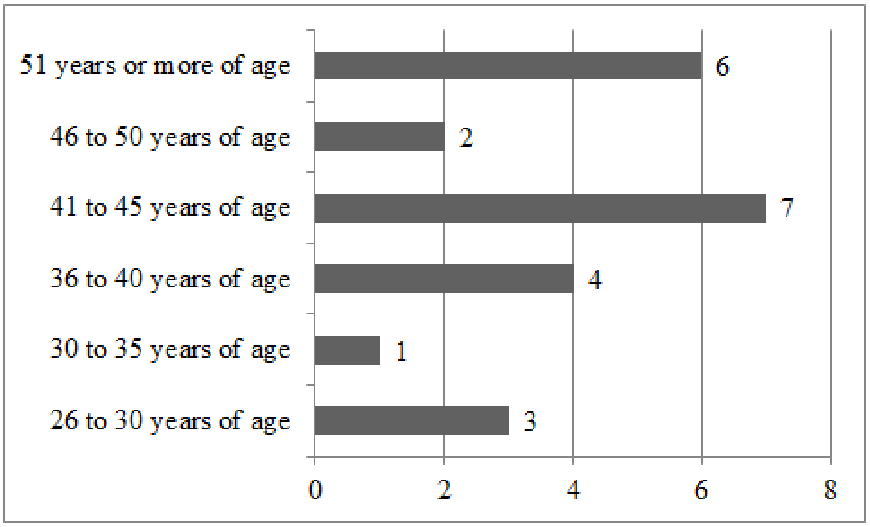

Figure 32. Survey – Participant Current Age

4. Please select the one most appropriate answer from the following list that best describes your highest level of education.

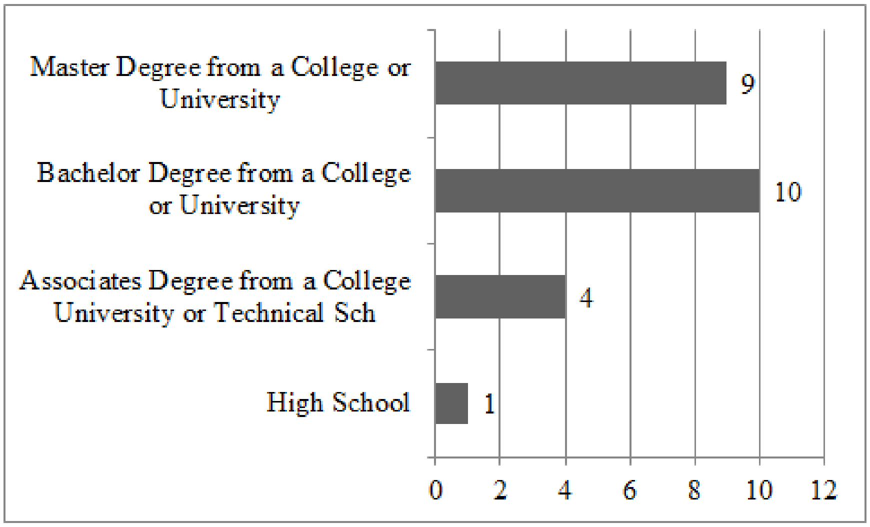

Figure 33. Survey – Participant Highest Level of Education

5. Please select the one most appropriate answer from the following list that best describes your total years of work experience.

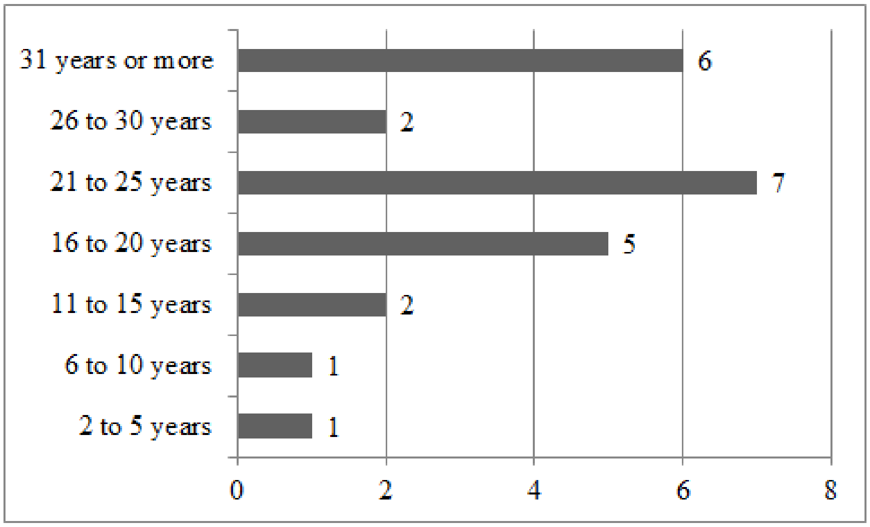

Figure 34. Survey – Participant Total Years of Work Experience

6. Please provide your current job title with DMS Global in the space below.

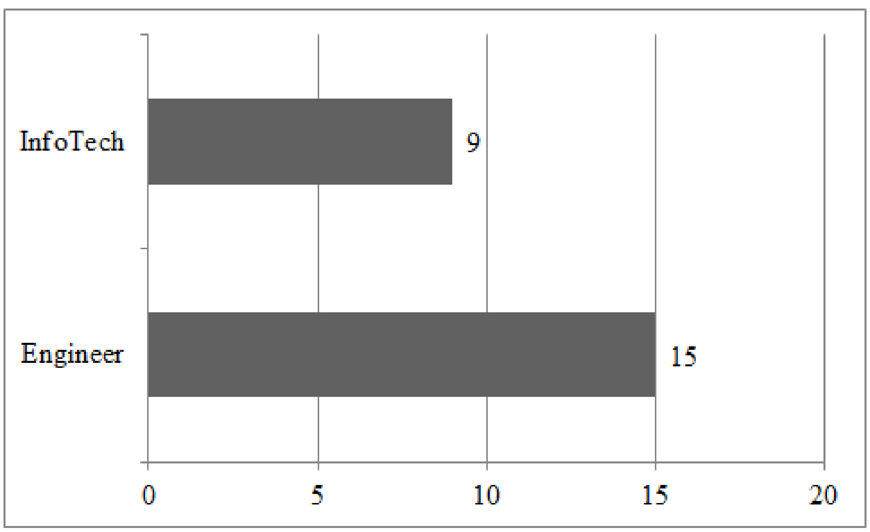

Figure 35. Survey – Participant Job Title

7. Please select the one most appropriate answer from the following list that best describes the number of years you have worked for DMS Global.

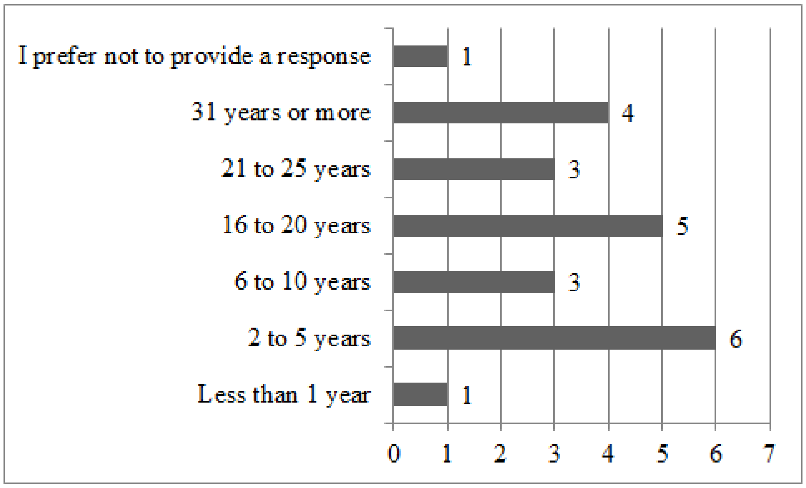

Figure 36. Survey – Participant DMS Global Years of Work Experience

8. Please select the one most appropriate answer from the following list that best describes the total amount of time you have been involved with the DMS Global PLM project.

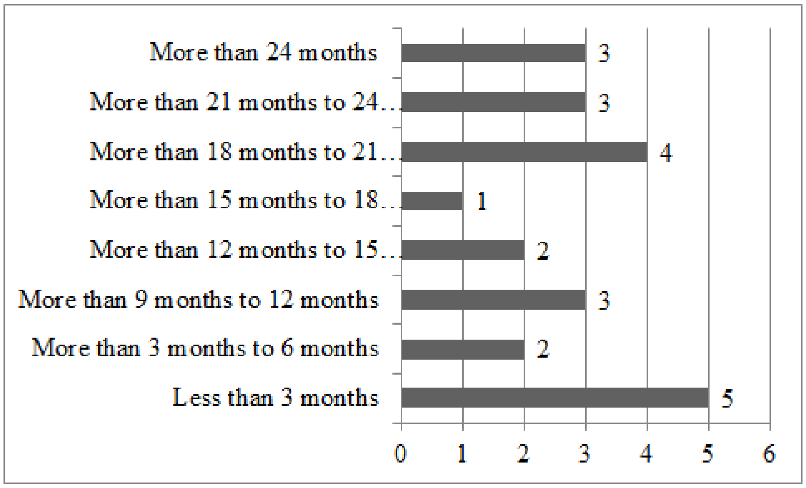

Figure 37. Survey – Participant Months of Work on PLM Project

9. Please select the one most appropriate answer from the following list that describes the current phase of your PLM project.

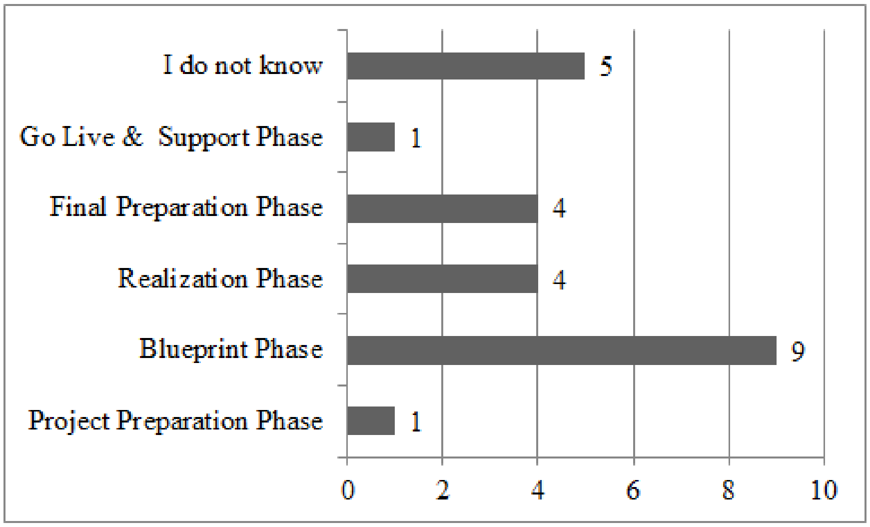

Figure 38. Survey – Participant Current Phase of PLM Project

10. If you have past global system implementation experience, then please briefly describe your past experience in the space below.

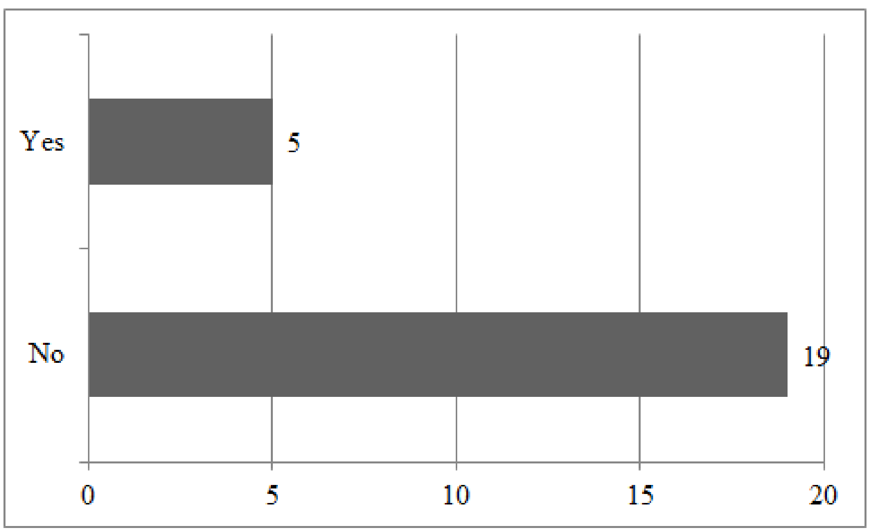

Figure 39. Survey – Participant Past Global System Implementation Experience

Survey – national culture – CSFs – top five & sig. ANOVA graphs.

Figure 40 through Figure 44 contain the top five ranked CSFs by national culture and CSFs with statistically significant differences as determined by the ANOVA for national culture from the stage two survey. These figures are graphical representations of the data in Table 13 through Table 17.

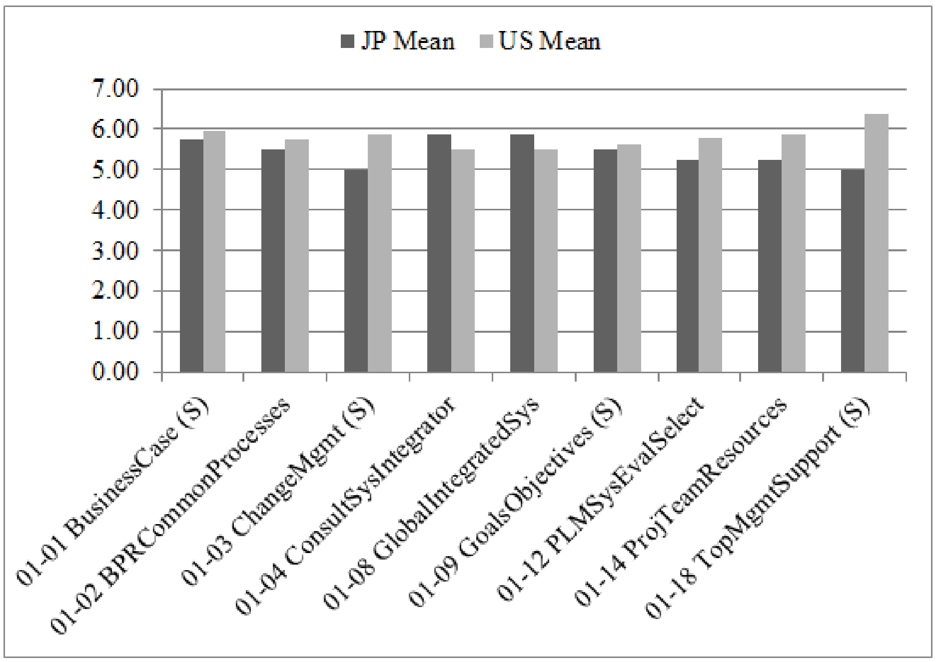

Figure 40. Survey – National Culture – CSFs Top 5 & ANOVA 01 Project Prep.

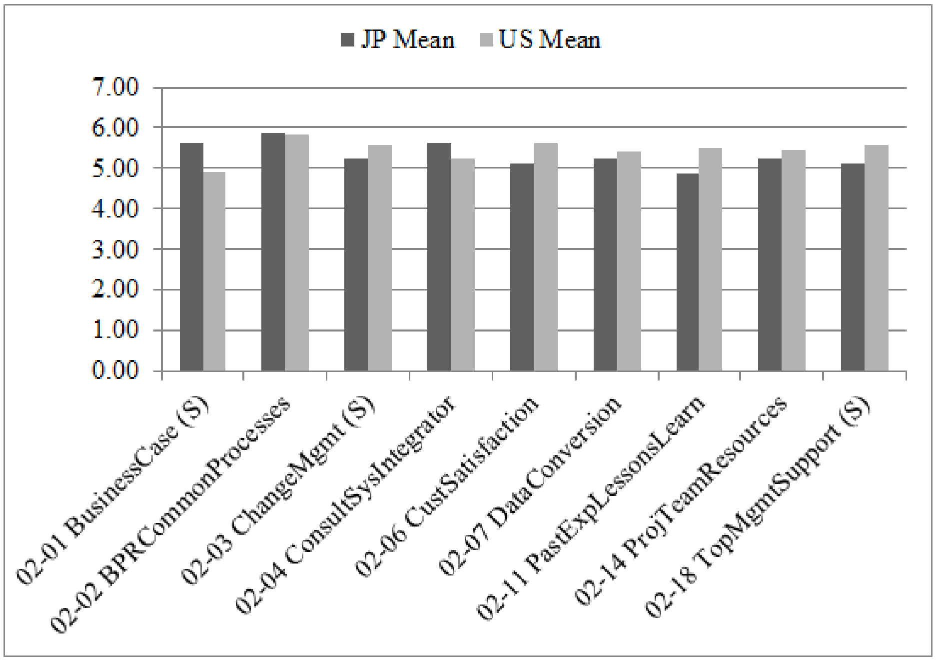

Figure 41. Survey – National Culture – CSFs Top 5 & ANOVA 02 Blueprint

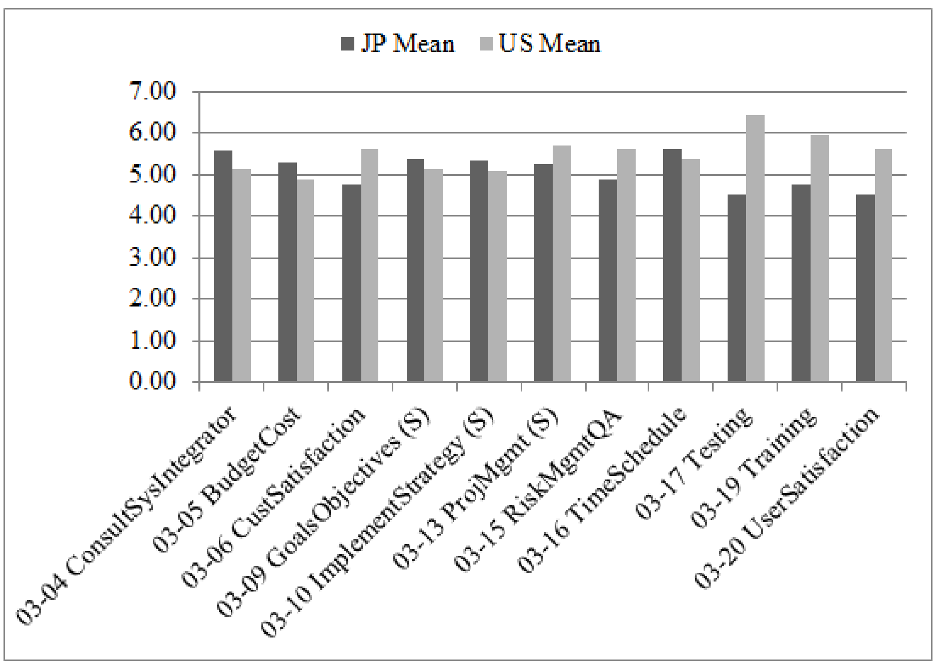

Figure 42. Survey – National Culture – CSFs Top 5 & ANOVA 03 Realization

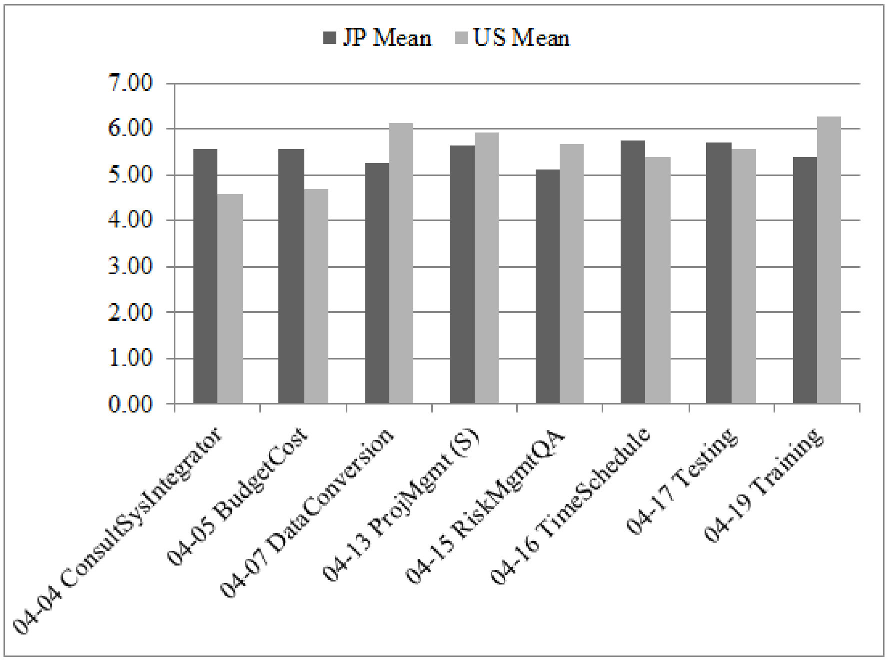

Figure 43. *Survey – National Culture – CSFs Top 5 & ANOVA 04 Final Prep.*

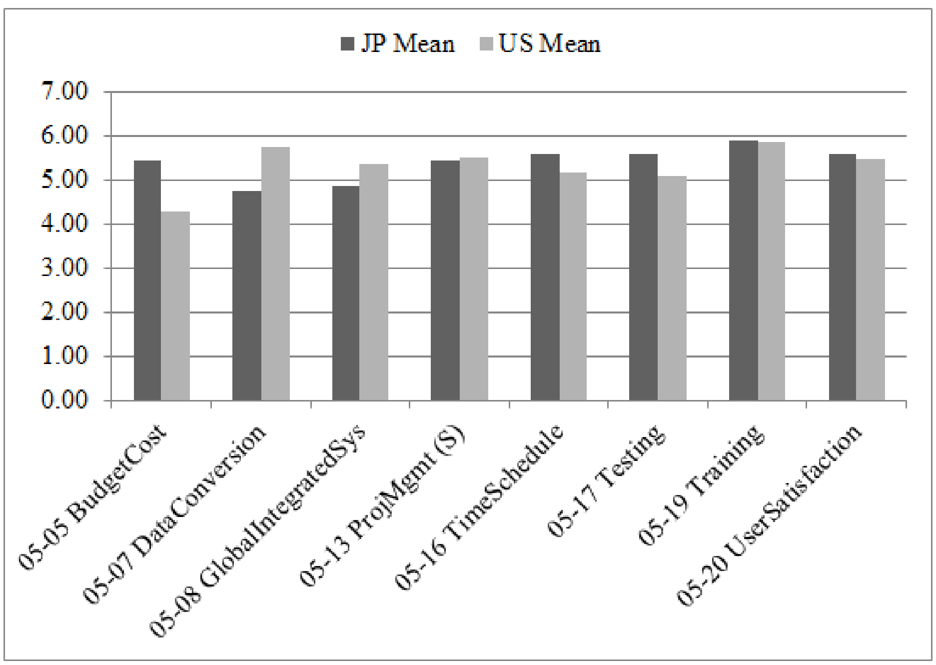

Figure 44. *Survey – National Culture – CSFs Top 5 & ANOVA 05 Go Live & Sup.*

Survey – prof. culture – CSFs – top five & sig. ANOVA graphs.

Figure 45 through Figure 49 contain the top five ranked CSFs by professional culture and CSFs with statistically significant differences as determined by the ANOVA for professional culture. These figures are graphical representations of the data in Table 20 through Table 24.

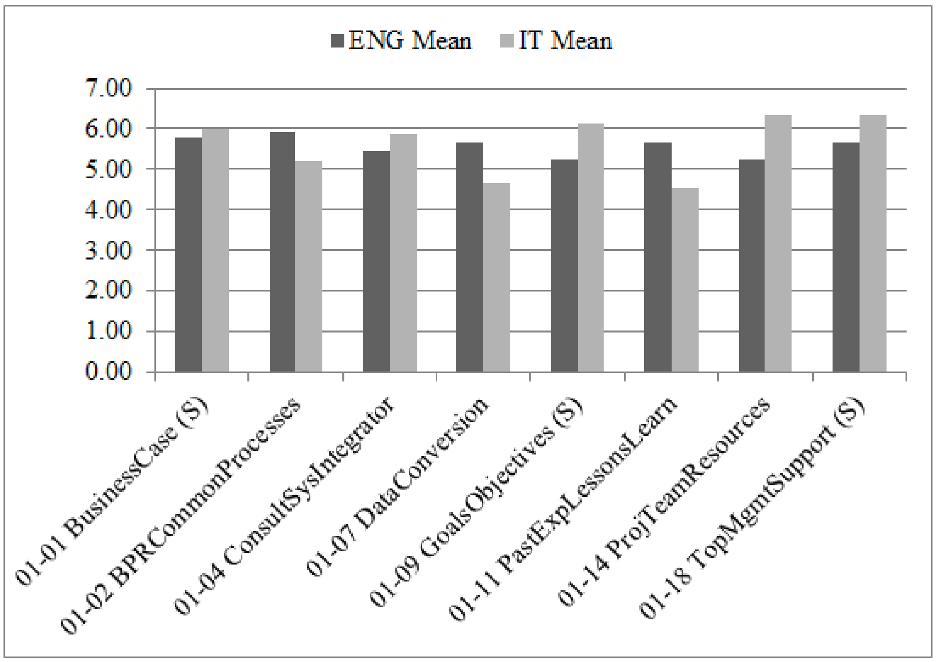

Figure 45. *Survey – Professional Culture – CSFs Top 5 & ANOVA 01 Project Prep.*

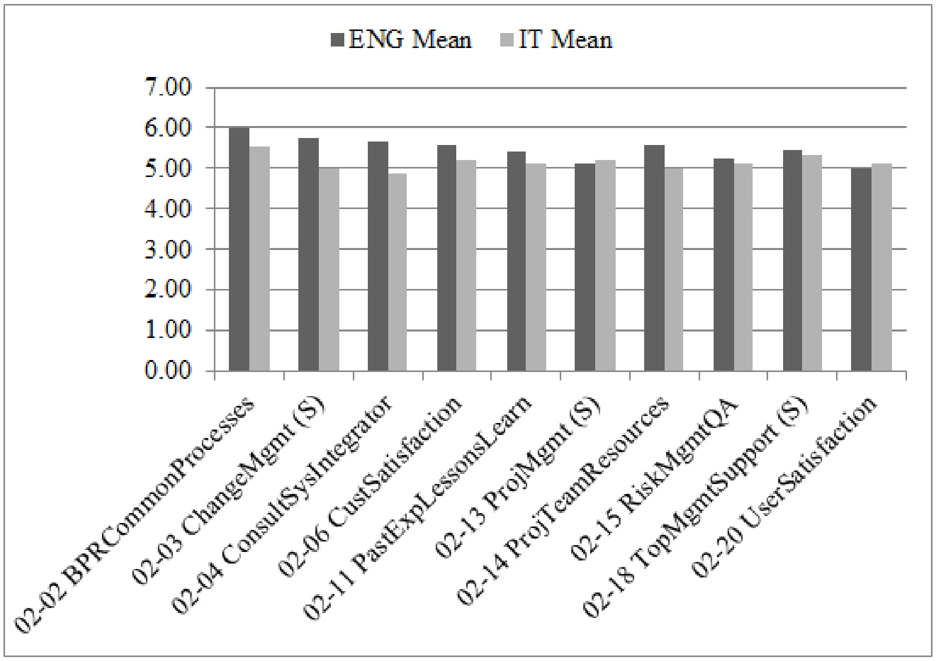

Figure 46. Survey – Professional Culture – CSFs Top 5 & ANOVA 02 Blueprint

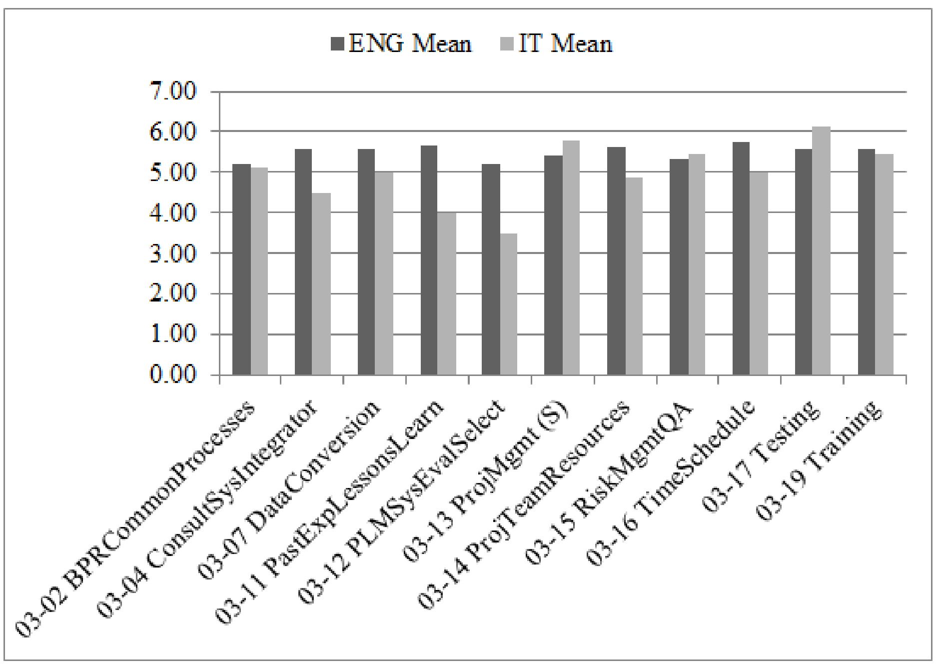

Figure 47. Survey – Professional Culture – CSFs Top 5 & ANOVA 03 Realization

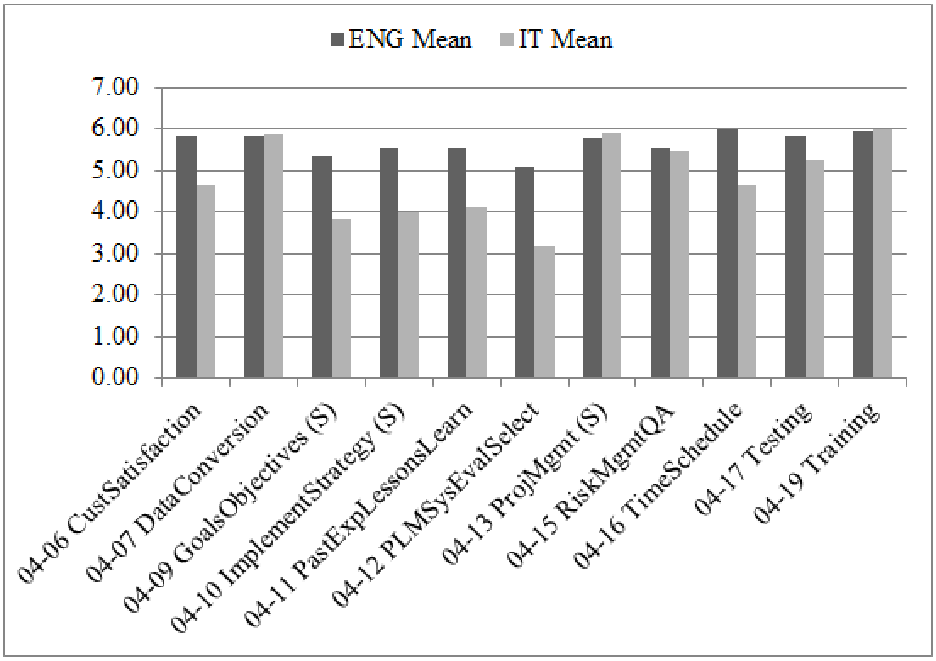

Figure 48. Survey – Professional Culture – CSFs Top 5 & ANOVA 04 Final Prep.

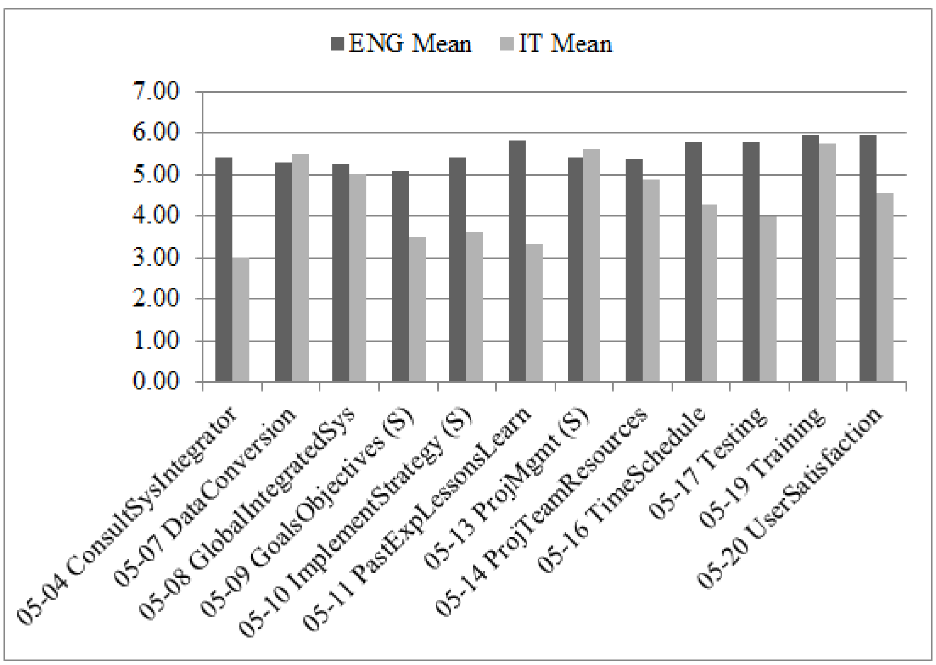

Figure 49. Survey – Professional Culture – CSFs Top 5 & ANOVA 05 Go Live & Sup.