Assessing Knowledge Management Maturity within NASA's Johnson Space Center

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ABSTRACT

Johnson Space Center (JSC) has been directed to establish new innovative programs in engineering while continuing to fulfill the requirements of its current programs. As a result, the Space Shuttle Program is transitioning to a new innovative program called Constellation which is expected to become just as, if not more, critical. To aid in this transition while retaining and preserving institutional knowledge and expertise for the next generation of engineers, program managers and leaders, the center needed mechanisms in place to manage the sharing and acquisition of knowledge throughout the entire knowledge lifecycle. First, the CKO sponsored a Knowledge Management Assessment Project (KMAP) to determine the knowledge management maturity of the center. This was the first step in developing and implementing a KM roadmap. To accomplish the KMAP, SAIC used a mixed methods approach to assess the approximately 10,000 civil servants and contractors across the center. First, focus groups and interviews were used to understand JSC's as-is environment. Utilizing the qualitative Global Knowledge Management Maturity Model (G-KMMM) developed by Pee, Teah, and Kankanhalli (2006), a quantitative instrument (Q-Assess) was developed by SAIC and tailored using results from the qualitative analyses. Implemented online, the Q-Assess represented 12 sub-assessments for assessing levels of maturity across the KPAs (key performance areas) of people, processes, and technology. Using the Q-Assess results as the condition and the G-KMMM itself as the criterion, a multi-unit gap analysis was produced. As JSC's KM maturity was identified within each unit, recommendations were than developed to facilitate the attainment of the next level of maturity. These results fed the development of the roadmap. This roadmap contained the implementation of knowledge and technology audits leading to the development of an organizational knowledge architecture and enterprise architecture in support of knowledge management, ensuring shareability, compatibility, and preservation.

ABOUT THE AUTHORS

Patrick Shane Gallagher, Ph. D. is currently the technical lead for the Advanced Distributed Learning initiative and a program manager for SI International. He was the Chief Knowledge Engineer/Instructional Technologist for the Performance Improvement Operation within the Analysis, Simulations, Systems Engineering, and Training (ASSET) Business Unit of Science Applications International Corporation (SAIC). Dr. Gallagher has a successful track record in leading, designing, and implementing enterprise learning and development solutions specializing in the convergence of enterprise learning and knowledge technologies. He led the knowledge management support for the NASA Johnson Space Center office of the CKO and was also the analysis team lead and knowledge architect for the Joint Knowledge Development and Distribution Capability (JKDDC) project for the Department of Defense (DoD) and the JKDDC Joint Management Office. Dr. Gallagher has extensive experience in designing and developing learning and knowledge architectures and systems and has led an internal research and development project for SAIC in the design and development of new content object models to support smart enterprise systems. Dr.

Gallagher has accrued customer recognition and awards for thought leadership, innovation, and design and continues to pursue models for convergence in the areas of e-learning and knowledge management.

Hasan Altalib has over 17 years of Management Consulting, enterprise Knowledge Management and Training experience in the private sector and consulting with government agencies. He has successfully applied his knowledge management, and instructional system design expertise on projects for the Department of Agriculture, Department of Interior, Department of Defense, and the Joint War fighting Community. He has managed projects involving the design, development and implementation of knowledge management solutions including, knowledge management maturity assessments, knowledge mapping, knowledge architectures, knowledge portals, and collaborative environments. He also managed a number of performance support and courseware development efforts that include interactive performance modules, instructor led and web-based training courses. In his current role as a team manger at SAIC Mr. Altalib is involved in the development and implementation of enterprise knowledge and training solutions, he has been a thought leader in the area of Knowledge Harvesting which is an object oriented approach for content development involving the creation of reusable information objects, knowledge objects and learning objects. Mr. Altalib is responsible for managing the development processes, business rules, metrics, tools and technology, metadata models and documentation that support knowledge object creation. Mr. Altalib holds an MBA for Georgetown University and a M.Ed. in instructional system design from George Mason University. Mr. Altalib has published various articles including, Return on Investment Calculations for Electronic Performance Support Systems, and The Use of Mobile-Wireless Technology for Education. To contact Mr. Altalib please email him at, altalibh@saic.com.

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BACKGROUND

In 2005, Congress endorsed the President's Vision for U.S. Space Exploration, a new directive designed to take NASA back to the moon and eventually to Mars. This directive challenges NASA to establish new, innovative programs for space exploration over the next twenty years while continuing to fulfill the requirements of current programs. As the Space Shuttle Program (SSP) nears its final flight in 2010, NASA will face its most significant organizational change since the transition from Apollo to the Orbiter. The Johnson Space Center (JSC), as the center for Human Space Flight and the primary location for the SSP, International Space Station (ISS), and Constellation[1], will be a crucial developer of the Constellation Program and many other projects which will enable NASA to successfully implement the President's Vision for Space Exploration. The JSC is facing several significant changes which include:

- Space Shuttle Retirement,
- Development of the Orion (CEV) and Ares 1 (CLV), and
- Human Capital Losses.

To meet a current presidential directive for space exploration, prepare for the potential loss of critical capabilities, and ensure a smooth transition from the Shuttle Program to the Constellation Program, the JSC needs mechanisms in place to manage the flow of its knowledge and continue to grow as a learning organization. Embedding knowledge management capabilities across the center should foster and enhance collaborative efforts, build stronger communication activities among and across directorate lines, capture and document critical knowledge, and transfer that knowledge from one generation to the next.

In response to the growing need for a focused knowledge management and organizational learning initiative at JSC, the director created the office of the Chief Knowledge Officer (CKO) in October of 2006. JSC's first CKO was chartered with developing a world-class knowledge management and organizational learning program. JSC's CKO serves as a facilitator to other centers, organizations, public sector, academia, and contractors to accomplish JSC's goal of creating better knowledge sharing and organizational learning across the center.

The *European Guide to Good Practice in Knowledge Management* defines **knowledge** as "the combination of data and information, to which is added expert opinion, skills, and experience, to result in a valuable asset which can be used to aid decision making. Knowledge may be explicit and/or tacit, individual and/or collective."[2] *Australian Standard* further defines **knowledge management** as "a trans-disciplinary approach to improving organizational outcomes and learning, through maximizing the use of knowledge. It involves the design, implementation, and review of social and technological activities and processes to improve the creating, sharing, and applying or using of knowledge"[3] This project at the JSC viewed knowledge management (KM) as a systematic approach for developing, maintaining, and evolving an environment that enables greater collaboration, sharing, and reuse of information, intelligence, and experience for problem solving, innovation, and learning across people, processes, and technology.

JSC's collective success is dependent upon the ability and pace in which its directorates, divisions, and programs continuously learn from their experiences. Sharing and transferring knowledge and information is required for growth and continued success, and the JSC understood that this depends upon leaders and staff routinely using the latest best practices inside and outside their organizations. As a first step in achieving KM objectives, JSC conducted the Knowledge Management Assessment Project (KMAP) to ascertain

[1] The Constellation Program includes the program management, the Orion crew exploration vehicle (CEV), Aries 1 crew launch vehicle (CLV) as well as other projects.

[2] European Guide to Good Practice in Knowledge Management, Part 1, 2004, p. 6.
[3] Australian Standard, 2005, p. 2.

the "as is" state of knowledge management capabilities at the JSC.

This initiative and its delivery was a robust, customized approach intended to set the JSC on the path toward sustainable high business performance across the enterprise. The KMAP, developed over a 10-week study period, served to guide the recently chartered CKO office in its implementation of KM initiatives across the center. The scope of the work involved performing an enterprise-wide, holistic knowledge management assessment that included focus groups, thematic interviews, and an organizational survey. The primary objectives of this assessment were to provide a clear picture of the strengths, weaknesses, and risks of the current state of the JSC enterprise and to identify the highest value targets for "corrective" action and refinement of KM strategies.

The assessment examined the JSC's knowledge management maturity from learning processes to community development, technology utilization, roles and accountabilities, and risks to provide a macro-level score of progress along these vectors and target prospective areas for later KM interventions. Further, the KMAP initiative provided the data required for determining where and how to instill future KM interventions and included insights into their unique knowledge management culture, processes, and business practices. Ultimately, the KMAP provided the JSC with the ability to move toward its desired knowledge management "to be" state.

ASSESSMENT METHODOLOGY

In information technology, a gap analysis is the study of the differences between two different information systems or applications, often for the purpose of determining how to get from one state to a new state. A gap is sometimes spoken of as the space between where we are and where we want to be with the states also referred to as the "as is" and the "to be." The purpose of a gap analysis is to decide how to bridge that space (SearchSMB.com 2006).

In the analysis of any organization, a gap analysis is a crucial component of the front-end or needs assessment leading to the understanding of the as-is state and recommendations for improvements. Within this framework, a gap analysis occurs as the technique supporting the front-end analysis used for identifying if problems exist and their nature (Gallagher and Altalib 2006). Gap analyses use the terms "what is" and "what should be" for identifying the existing and ideal states. More formally, however, the "what is" is called the condition, the "what should be" is called the criterion, and the difference between the two are called the gaps. The reason for the gap is called the cause and its consequences are referred to as the symptoms (Rothwell and Kazanas 1998).

This assessment made use of the gap analysis methodology to identify the criterion known as the existing state of KM processes and practices described as the KM maturity of the organization known as the Johnson Space Center (JSC) (Figure 1). Using the existing state of KM maturity within JSC as the condition, this assessment identified the gaps between the states and the criterion known as the General Knowledge Management Maturity Model (G-KMMM) (Pee, Teah et al. 2006). Subsequently the causes and symptoms of the gaps were identified leading to recommendations of improvement. In so doing JSC was given a report card indicating what level of KM maturity the organization as a whole as well as appropriate directorates have attained based upon the G-KMMM.

Assessment of KM Maturity (Condition)

To assess the KM maturity across JSC, a mixed-methods approach was used. This approach combined both qualitative and quantitative methods to not only understand and describe the current processes, programs, practices, and approaches used throughout but also to contextualize and tailor the items in an organizational-wide quantitative assessment. The combination of methods allowed for the development of tailored approach capturing perceptions and attitudes of what is actually going on at the organizational and directorate/divisional levels.

Qualitative Data Collection Methods

Qualitative data collection and analysis played an important role in the overall assessment. It was used to understand the culture and important issues present within JSC in terms of KM facilitating the contextualization of the assessment process as a whole. Particularly, it was used to tailor assessment questions, provide insight and corroborating evidence of findings, and explicate specific instances or cases of programs and processes that illustrate where KM practices are already embedded and having positive effect.

Qualitative data collection methods consisted of focus groups centering upon seven critical focus areas used as an initial lens in understanding JSC organization. Using a pre-developed questionnaire as a guide, the

focus groups were used to begin to understand JSC organization, uncover issues, determine direction, and finally, tailor and customize assessment questions for quantitative analysis.

Another qualitative technique used was that of interviews. Interviews were used to probe deeper into focus group issues for clarification and richer data. Also, based upon an interview guide, interviews were used to look for existing programs and cases exhibiting attributes of KM maturity. Interviews were then conducted around specific programs at JSC as case studies and used to further bolster qualitative data.

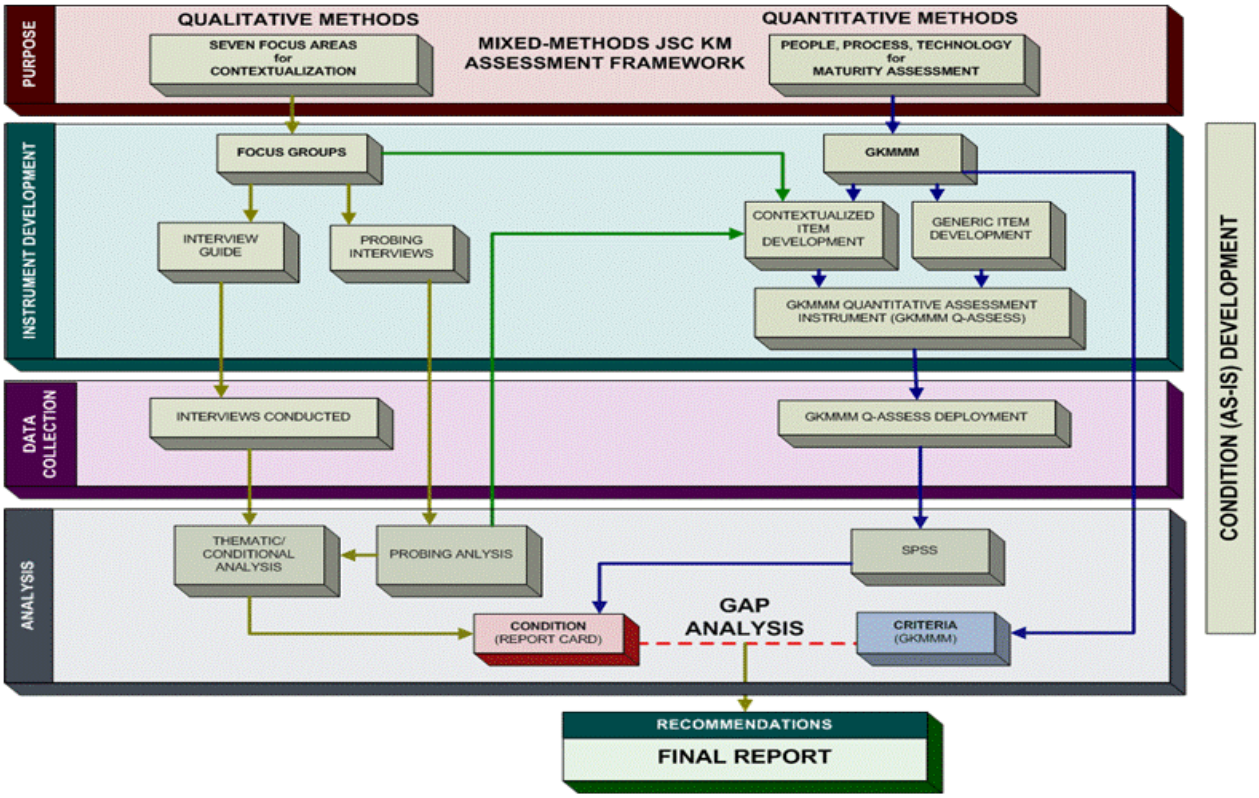

Figure 1 Mixed-Methods JSC KM Assessment Framework

To facilitate and enable data collection within the focus groups, an online questionnaire called the Phase I Questionnaire (Data Call) was developed that was deployed on the World-Wide Web (WWW). This questionnaire consisted of 24 questions organized by learning processes and practices; cross-organization sharing; knowledge stewardship and utilization; strategic alignment; roles, accountability, and resources; behavior incentives/rewards; and technology enablers.

Two interview guides were developed. One for interviews recommended by the office of the chief knowledge officer and those chosen at random. The interview guide for recommended interviews was labeled the Case Study Guide and consisted of 11 questions intended to understand specific programs and their attributes. The interview guide for randomly chosen interviews was based upon the previously described focus group questionnaire and was called the Probing Interview Guide.

Quantitative Data Collection Methods

Quantitative data were collected to assess the condition or KM maturity at the organizational and divisional levels. Data were collected using an online survey accessible on the WWW and deployed across the JSC. The deployment time period was from April 12, 2007 to April 21, 2007 and assessed the general JSC population. Demographics were collected and used to stratify the data by employee category (government or contractor), GS level, contractor level, division/directorate, years at NASA, and years at the JSC.

The JSC is comprised of approximately 10,000 civil servants and contractors spread across 26 different

directorates. Of the 10,000 JSC employees, approximately 3,000 of them are civil servants and 7,000 are on-site contractors. The JSC houses three program offices, the International Space Station (ISS), Space Shuttle Program (SSP), and Constellation program and manages one offsite center, the White Sands Testing Facility in south central New Mexico. Combined, the program offices contain approximately 2400 employees, and Whites Sands Test Facility has about 1500 employees. Staff offices, which include center director, external relations, human resources, legal, and others have about 277 employees, while the remainder of the employees, approximately 5500, belong to site support and research offices like procurement, center operations, space life sciences, engineering, and mission operations.

To assess quantitatively the level of KM maturity across the JSC and the levels associated with each division, a quantitative survey instrument was developed based on the G-KMMM called the Q-Assess for analysis and discussion and labeled online as the JSC G-KMMM Assessment. The Q-Assess consisted of 67 response items mapped to the assessment areas or key performance area (KPA) and the maturity levels 2-5. Level one maturity was not applicable to the scope of this assessment and was therefore not assessed. The Q-Assess used a 6 point Lickert scale measuring levels of agreement from not applicable (1), through strongly disagree to strongly agree (6). All statements were positive towards KM maturity and, ideally, should be applicable; therefore a rating of not applicable (NA) was equal to a rating of 1 numerically.

Items were derived from two sources: the G-KMMM and from the JSC qualitative data. The G-KMMM qualitative rubric was used to develop general quantitative assessment items. Input from the focus groups on the Data Call and probing interviews were the basis of a tailored or contextualized set of items that combined with the general ones formed the set of Q-Assess response items. Items were indirectly mapped to the original focus areas by mapping them to each KPA which was, in turn, mapped to corresponding focus group area (Figure 2).

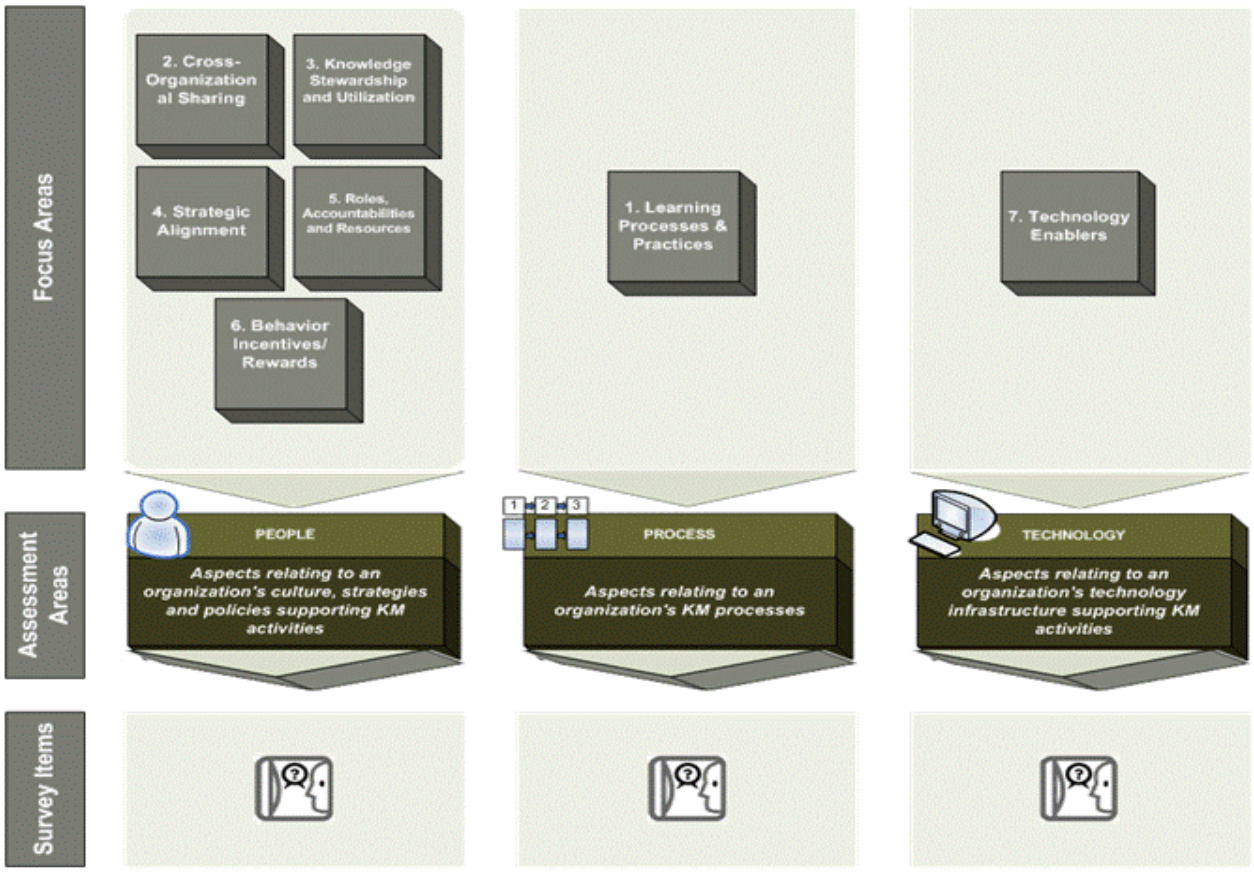

Figure 2 Focus Area Mapping

Timeline

Phase I (March 5 – March 23, 2007) - The Data Call was deployed on the World-Wide Web (WWW) to facilitate the collection of data through focus group processes. Initially, a working group from within the JSC was formed and subsequently members of the working group convened and led focus groups. Using the Data Call as the guide, the focus group leaders convened the groups and worked towards filling out the Data Call. These data were then analyzed for its condition and gaps leading to the identification and development of the probing interviews and Probing Interview Guide. Probing interviews subsequently began with overlap into the next phase of the assessment.

Phase II (March 24 – May 4, 2007) - During this phase, Case Study interviews were conducted with recommended personnel. Case Study interview data were transcribed during this phase and analyzed. Also during this phase the probing interviews were finalized and these interview data were then transcribed and analyzed.

Based upon data from the focus groups and the probing interviews, the Q-Assess items were finalized. Items were randomized into a single form after which the Q-Assess was deployed on the WWW April 10 through April 21, 2007. The resulting data set was compiled and prepped, and analyzed.

Phase III (May 4 – May 17, 2007) - All data were analyzed and the condition was determined. Based upon the data, JSC and the divisions were scored and assigned an overall level of KM maturity.

Qualitative Analysis

The data were thematically analyzed using a constant comparative method of analysis. Such a technique involves the quantification of repeated themes heard in the interview sessions. When an idea or theme is mentioned by a participant that theme is noted. When the same idea or theme is supported or mentioned again by another participant it is scored accordingly. Results are presented in order of the intensity of response. The first idea or theme presented under each subject heading will represent the most repeated idea or theme presented by the participants, the second item listed is the next most repeated idea or theme and so on. This technique was applied to both the focus group data and all interview data. Case study interviews were used to bolster themes identified from the random interview.

Quantitative Analysis

Population Description

The sample of respondents completing the Q-Assess consisted of 698 valid cases of which 324 were civil servants and 368 were contractors with six marked "other." A case was considered valid if it was flagged as complete and had responded to a majority of the items. Also, out of the 698 all government service (GS) levels were represented with the most representation in the GS 10-15 ranges producing a normal distribution. Contractor levels measured in 0-5 years, 5-15 years, and 15-30 years also had the highest representation in the 5-15 year category implying a normal distribution. An anomaly in the demographic data collection allowed civil servant and contractor to input data in both areas with a choice of not applicable (NA). The values for NA across both demographics are similar implying that they did, in fact answer both questions using NA where applicable and effectively nullifying each other in the analysis. Years at JSC and years at NASA were almost identical in the population suggesting a self-contained and stable workforce. The previous demographics are illustrated in Figures 3-7.

Variable Descriptions and Data Coding

The dependent variables used in the analysis were GLEV2, GLEV3, GLEV4, GLEV5, P2SCORE, P3SCORE, P4SCORE, P5SCORE, PR2SCORE, PR3SCORE, PR4SCORE, PR5SCORE, T2SCORE, T3SCORE, T4SCORE, T5SCORE, L2SCORE, L3SCORE, L4SCORE, and L5SCORE. The independent variables were the mean value of each response item corresponding to the question number and KPA. All independent variables were grouped by KPA and level (levels 2-5) then analyzed for the mean values. They were then recoded as a P or and F for pass or fail based upon a passing value >3.6 or 60%. These procedures allowed the determination of final scores by maturity level globally, by KPA, and by division.

Analysis of Variables

After restructuring and recoding took place, descriptive and exploratory analyses were run. These analyses looked for frequencies and normality of the

dependent variable values. Results were displayed in tables of descriptive statistics, histograms, stem and leaf plots, and boxplots. Frequencies of cases by division were analyzed to facilitate factoring the dependent variables by division. The filter variable DIRFILT was created for selection of cases with counts => 10 for division level analysis.

Following the descriptive and as part of the exploratory analyses, frequency counts were used to defined the percentages of passing scores overall as the dependent variables L2SCORE, L3SCORE, L4SCORE, and L5SCORE; and by KPA as dependent variables P2SCORE, P3SCORE, P4SCORE, P5SCORE, PR2SCORE, PR3SCORE, PR4SCORE, PR5SCORE, T2SCORE, T3SCORE, T4SCORE, and T5SCORE. Scores were factored by employee category and by selected divisions (those with => 10 cases). All independent variables were analyzed descriptively looking at frequencies and normality. The means of these data were compared and plotted for item by item analysis.

To Be State (Criterion)

After reviewing the literature including past studies performed by SAIC, the criterion was determined based upon the work done by Pee et al. Synthesizing the existing KM assessment tools used by consulting firms such as KPMG, Klimko, and Siemens based on the Capability Maturity Model (CMM) and non-CMM models, they developed a CMM-based rubric for assessing KM maturity called the General Knowledge Management Maturity Model (Pee, Teah et al. 2006)**.** As a rubric synthesized from the best practices across the industry, the model was chosen to function as the criterion or gold-standard by which to assess the condition of KM maturity across JSC.

General Knowledge Management Maturity Model (G-KMMM)

The General Knowledge Management Maturity Model (G-KMMM) is a descriptive model in that it describes the essential attributes that characterize an organization at a particular KM maturity level. It is also a normative model in that the key practices characterize the ideal types of behavior that would be expected in an organization implementing KM.

Similar to the majority of existing CMM-based and non-CMM-based KMMMs, the G- KMMM follows a staged-structure and has three main components, namely maturity levels, key performance areas (KPAs) and common characteristics. Each maturity level is composed of several KPAs, and each KPA is described by a set of common characteristics. These characteristics specify the key practices that, when collectively addressed, help to accomplish the goals of a KPA. This structure is organized in matrix in Table 1 below.

The KM literature reveals that like the CMM, most existing KMMMs (both CMM-based and non-CMM-based) identify five levels of maturity. Accordingly, the G-KMMM adapted five levels of maturity from CMM and named them initial, aware, defined, managed, and optimizing respectively. Level 2 was renamed from “repeatable” to “aware” considering that “repeatable” is less intuitive in the KM context and that level 2 is mainly characterized by awareness of the need to manage knowledge.

The G-KMMM dictates that organizations should progress from one maturity level to the next without skipping any level. In practice, organizations may beneficially employ key practices described at a higher maturity level than they are. However, until a proper foundation is laid, these practices are unlikely to attain their full potential. As maturity levels describe the issues that predominate at a level, skipping levels can be counter-productive because each level forms a necessary foundation from which to achieve the next. Hence, the ability to implement practices from higher maturity levels does not imply that maturity levels can be skipped.

The majority of the KMMMs currently in practice identify people-related, process-related and technology-related KPAs. The remaining KMMMs also refer to these aspects even if they do not explicitly mention these KPAs. It is expected that these KPAs, when used in conjunction, can provide a comprehensive assessment of an organization’s KM maturity. In view of the observation that most KMMMs combine people and organization into a single KPA and to preserve parsimony, this framework thus defines three KPAs, namely people, process and technology. These KPAs concur with suggestions of Pee et al that KM needs to consider organizational, human (i.e. psychological and sociological) and technological aspects in order to deliver thorough and successful business support. The people KPA includes aspects related to culture and organization’s strategies and policies; the process KPA refers to aspects concerning KM processes; and the technology KPA relates to aspects about KM technology and infrastructure (Pee, Teah et al. 2006).

Gap Analysis

For gap analysis, the condition was first established. This consisted of the quantitative maturity assessment of JSC KPAs by level producing pass/fail results. Taking the mean of the KPA level scores an overall passing percentage was produced. If the overall percentage was 60% or above that level was considered attained if preceding levels were also attained. According to the G-KMMM, all previous levels must be attained as well. The results of the overall level attainment and those of each KPA combined with the analysis of the qualitative interview and relevant focus group data became the condition or as-is state of the KM maturity of JSC.

Maturity Level			General Description	Key Performance Areas		
				People / Organization	Process	Technology
1	Initial	⇨	Little or no intention to make use of organizational knowledge	Organization and its people are not aware of the need to manage its knowledge resources	No formal processes to capture, share and reuse organizational knowledge	No specific KM technology or infrastructure in place
2	Aware	⇨	Organization is aware of and has the intention to manage its organizational knowledge, but it might not know how to do so	Management aware of the need for KM	Knowledge indispensable for performing routine task is documented	Pilot KM projects are initiated (not necessarily by management)
3	Defined	⇨	Organization has put in place a basic infrastructure to support KM	- Management is aware of its role in encouraging KM - Basic training on KM are provided (e.g. awareness courses)	- Processes for content and information management is formalized - Metrics might be used to measure the increase in productivity due to KM	- Basic KM Infrastructure in place (e.g. single point of access)
4	Managed / Established	⇨	KM initiatives are well established in the organization	-Common strategy and standardized approaches towards KM - KM is incorporated into the overall organizational strategy	Quantitative measurement of KM processes (i.e. use of metrics)	- Enterprise-wide KM systems are fully in place - Usage of KM systems is at a reasonable level
5	Optimizing Sharing	⇨	KM is deeply integrated into the organization and is continually improved upon It is an automatic component in any organizational processes	Culture of sharing is institutionalized	- KM processes are constantly reviewed and improved on - Existing KM processes can easily be adapted to meet new business requirements	Existing KM infrastructure is continually improved upon

Table 1 G-KMMM Scoring Rubric

Using the G-KMMM as the lens and the independent variables (response items) as pointers, the condition of each KPA was assessed against the criteria of the next level attainment. This process uncovered the gaps between the current state of the practices, processes, and technologies compared to the to-be state of the next level criteria. As the gaps were discovered, they then became the basis of the recommendations.

External Validity

The sample used for this assessment is considered independent and representative of JSC as a whole. Using the 99% confidence level, the percentages reported for JSC as a whole are accurate to plus 5% and minus 5%. However, representation within each division sub-sample could not be determined and may not be representative at that level. Therefore this assessment is determined to generalize to the population of JSC but not at the division level.

Construct Validity and Reliability

It is assumed that the construct of the instrument is tailored appropriately to allow examination of KM maturity in the context of JSC. This was ensured by the mixed-methods approach. However, there were no repeated measures occurring for external reliability nor was there a pilot allowing for measures of internal consistency such as Cronbach's alpha.[4]

RESULTS

Results of the assessment are derived from a quantitative analysis of the Q-Assess as well as a qualitative analysis of the interview data. The quantitative analysis results in the maturity level assignment by KPA and overall. Combined with the

[4] Cronbach's alpha is a coefficient of reliability (or consistency) and is used to assess the consistency of results across items within a test (developed by Lee Cronbach).

qualitative analysis, this assessment becomes the condition for the gap analysis. This section, then has two main areas, the quantitative analysis of the Q-Assess, and the gap analysis containing the corroborating qualitative data and the gaps between the current level of maturity and the next level.

Quantitative Analysis of the Q-Assess

The results of the quantitative analysis of the Q-Assess, are displayed as three units of analysis: Division/Directorate, KPA, and Overall. In the division/directorate unit out of 106 possible division/directorate choices, 87 were represented. The lowest number of respondents at this level was 1 and highest was 43.

Division/Directorate Analysis

Out of the 87 division/directorates, 25 had a respondent rate of => 10 and were further analyzed for a KM maturity assignment (Figure 3). Of those division/directorates analyzed for level 2 maturity, 21 passed with a mean of =>60%. For Level 3, 49% of the directorates passed, for Level 4, 38% passed, and for Level 5, the rate was 66%.

KPA Analysis

The next unit of analysis was at the KPA level across JSC. This included all respondent data on every response item answered. Means were coded categorically into pass/fail with a 60% pass cutoff. Data were factored by KPA and level. The results of the analysis by KPA were a KM maturity level of 2 for People, a level 3 for Process, and a level 1 for Technology. The KPA/level scores were presented to the JSC in 11 tables. To assist in score interpretation, levels passed are marked with a green "P" and the score is in green. Levels not attained are marked with a red "NA" for not attained. As an example, the Level 2 score "people" is displayed below. (Figure 3)

P		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	F	106	15.2	15.2	15.2
	P	592	84.8	84.8	100.0
	Total	698	100.0	100.0	

Figure 3 Scoring Example

As the JSC overall passed at a level five, they failed at both levels two and three. To obtain a maturity level within the G-KMMM, previous levels must be attained. This condition left the center at a level 2 overall.

Overall

To attain an overall score, the 3 KPA scores were averaged by level. The results of the overall analysis were the attainment of a Level 2 for KM Maturity. The average scores by maturity level were displayed in the report to the JSC. Color coding and the P and NA identifiers are presented here to demonstrate how scores were interpreted. (Figures 4 and 5)

Overall Level is 2

Level 1	**Level 2**	Level 3	Level 4	Level 5
N/A	**67%**	49%	38%	66%*
Initial	Aware	Defined	Managed Established	Optimizing Sharing
There is little or no intention to make use of organizational knowledge	**The organization is aware of and has the intention to manage its organizational knowledge, but it might not know how to do so.**	The organization has put in place a basic infrastructure to support KM.	KM initiatives are well established in the organization	KM is deeply integrated into the organization and is continually improved upon It is an automatic component in any organizational processes

*To attain a Level 5, an organization must receive a 60% on the previous level as noted in the methodologies

Figure 4 Overall KM Maturity for JSC

Maturity Level	General Description	Key Performance Areas		
		People / Organization	**Process**	**Technology**
1. Initial	Little or no intention to make use of organizational knowledge	N/A	N/A	N/A
2. Aware	Organization is aware of and has the intention to manage its organizational knowledge, but it might not know how to do so	85%	83%	35%
3. Defined	Organization has put in place a basic infrastructure to support KM	34%	61%	56%
4. Managed / Established	KM initiatives are well established in the organization	32%	45%	38%
5. Optimizing / Sharing	KM is deeply integrated into the organization and is continually improved upon It is an automatic component in any organizational processes	87%	63%	43%

Figure 5 Overall KM Maturity for JSC by KPAs

GAP ANALYSIS

From the qualitative data as well as specific question scores from the Q-Assess, gaps were identified in reaching the next higher level of maturity by KPA. These gaps are listed below by KPA and level.

People

Employees at JSC had extensive social networks and relied on them heavily for problem solving, informal mentoring and sharing lessons learned. However, the lack of incentives for participating in KM activities that encourages knowledge sharing with those outside of ones network does not exist. Time and heavy work loads have also been identified as major barriers for knowledge sharing. Many people have

work weeks longer than 40 hours, so they feel they do not have the time to participate in knowledge sharing activities.

Processes

The lack of a formalized and standardized set of metrics and measurement around KM activities across directorates, divisions and programs has been identified as a major gap. For example, lessons learned processes at the center are governed by Directorate Level Organization Representatives (DLORs), who do not have the authority to validate or maintain lessons; their role is limited to just facilitating lessons learned. Furthermore, the lengthy process involved in creating lessons learned act as a roadblock and discourages employee participation in the program.

Technology

Even though a robust set of tools and technologies exit within the center, the number one barrier for knowledge sharing was the lack of a centralized planned, designed, executed and managed enterprise architecture, which has significantly impacted the level of interoperability, compatibility, and shareability. Also, the lack of a common information and content architecture that enables knowledge sharing does not exist. Many divisions have implemented localized systems that only support their needs and do not allow the passing of important information to others who may be able to extract or generate value out of it. This is well summarized in a comment received by a survey respondent "The problem that we've had is taking an establishment that's very closed to access—very touchy about access to things—and over time trying to convince them that the value to their data is not in hording it but in sharing it."

RECOMMENDATIONS

To address the gaps identified from the initial KM assessment of maturity for the JSC, it was recommended that a phased approach be taken. These phases will address both long-term and short-term KM goals and objectives. Initially an enterprise architecture in support of knowledge management (EA_{KM}) and a knowledge architecture (KA) should be developed. The EA_{KM} will align the JSC's business strategy and IT investments as they support its KM needs. The KA identifies what knowledge and information is required based on users and tasks at the center. These architectures would leverage existing resources, current enterprise architectures at the JSC, and other assets across the organization. Activities involved in building the KA include in-depth audits such as a knowledge audit, training audit, and technology audit as well as knowledge mapping activities.

Simultaneously a pilot program consisting of several prototypes and pilot projects should be undertaken. These prototypes would address identified issues such as incentive structures, expertise location, and explicit (file and document) knowledge management. The pilot projects would focus on specific divisions within at least two directorates with included prototypes functioning as requirements generation activities that could be scaled up as desired.

Following the initial definition of the KA and EA_{KM} frameworks, activity should commence consisting of all identified development activities. Examples of these activities could be the development of a federation approach to existing and potential KM systems throughout the JSC. Another example could be the scaling up of existing successful prototypes.

CONCLUSION

By developing a quantitative assessment using the G-KMMM and tailoring it using qualitative methods, it was possible to successfully assess an organization the size of the JSC. Through the process of assessing for maturity, characteristics of success were evident by the identification of a number of key issues involving knowledge management activities. Employees are very willing to share knowledge and collaborate on problem solving, and lessoned learned. However, these activities occur within a multitude of social networks and on an informal basis. As determined through this assessment, the JSC's challenge in reaching KM maturity lies in formalizing KM activities through incentive structures, embedding KM practices in processes, and establishing common knowledge and technology architectures that facilitate collaboration and ensure preservation for future space exploration programs.

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