DEVELOPMENT OF THE HOLISTIC WORK SYSTEM FRAMEWORK (HWSF) WITH THE AID OF INFORMATION SYSTEMS RESEARCH DESIGN SCIENCE GUIDELINE

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ABSTRACT

DEVELOPMENT OF THE HOLISTIC WORK SYSTEM FRAMEWORK (HWSF) WITH THE AID OF INFORMATION SYSTEMS RESEARCH DESIGN SCIENCE GUIDELINE

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Today almost every market, either service or industry, is utilizing Engineering or Information Technologies (IT) in their Work Systems (WS) extensively. Enterprises operating in these markets continuously seek methods to increase the efficiency and effectiveness of this utilization to gain Business Value, and achieve Business Goals. Works on Business Process Management (BPM), Technology Adoption (TA), or Enterprise Architecture (EA) are major instances of such methods. There are several models or standards aiming to guide the users during their WS Activities. They are mostly fielding specific, highly textual and narrow scoped. Among these, yet there is no standardized unique complete set of best practices, neither comprehensive leading guidelines, nor complete frameworks in one view with full perspectives and common-sense. This deficiency is a well defined problem in WS field by many researchers.

For this reason, in this dissertation work, a solution to this ill-natured problem is proposed with a research design artifact. The artifact is a novel conceptual framework, namely the *Holistic Work System Framework (HWSF)*. The HWSF aims to depict all important entities of the WS. HWSF achieves this aim by harmonizing the necessary concepts of different disciplines in appropriate levels and dimensions with their relations. These enable the HWSF to catch holistic, interdisciplinary and systems approaches. This situation brings unique Socio-Technical WS Thinking in one view, in the HWSF. The HWSF is highly strong enough to guide the enterprises, practitioners and researchers in their WS Activities with such novelties.

This dissertation work is composed of domain analysis, literature survey, design, evaluation and discussion of the artifact. Analysis of the problem domain in detail with the aid of existing guides in different forms is done. In parallel, a deep survey on research and practice, in the literature is performed. Based upon to these, a concrete knowledge base is created as a foundation for the design and evaluation of the HWSF. On this foundation, the HWSF is designed in accordance with today's business trends and concepts. The HWSF is verified with descriptive, analytical, experimental and observational evaluation methods, as proposed in IS Research Design Guidelines. Finally, discussion and conclusion including the research rigor, contribution and future work is given. This work is believed to highly beneficial for both industry and academy by effectively and efficiently redressing the defined deficiency.

Keywords: Information Systems, Engineering Management, Systems Managament.

ÖZ

BÜTÜNLEŞIK İŞ SISTEMLERI ÇERÇEVE ÇALIŞMASI (BİSÇ)'NIN BILIŞIM SISTEMLERI ARAŞTIRMA TASARIM KULAVUZU YARDIMI ILE GERÇEKLEŞTIRIMI

Özalp, Egemen

Doktora, Bilişim Sistemleri

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Günümüz, hizmet ya da endüstri pazarları, İş Sistemlerinde (İS) yoğun olarak mühendislik ve bilgi teknolojilerini kullanmaktadır. Bu pazarlarda yer alan tüm kuruluşlar, iş değeri kazanarak iş hedeflerine ulaşmak için, bu kullanımın etkinliğini ve verimliliğini artırmayı hedeflemektedir. Bu arayışın en belirgin uygulamaları arasında süreç yönetimi, teknoloji kabulü ve kurumsal modelleme örnekleri görülmektedir. Bu ayrı çalışmalara kılavuzluk etmeyi iddia eden çeşitli model ya da standartlar mevcutur. Bunlar çoğunlukla uygulama alanına bağlı, dar kapsamlı ve metin yoğunlukludur. Halen de aralarında standardlaşmış tek bir en iyi uygulamalar seti veya herkesçe anlaşılır başlıca bir kılavuz ya da tüm boyut ve bakışları içeren ortak akıl ürünü tam ve tek parça bir çerçeve çalışması mevcut değildir. Bu eksiklik birçok araştırmacı tarafından bahsedilmektedir.

Bu nedenle, bu çalışmada, kemikleşmiş bu soruna bir araştırma tasarım eseri ile çözüm önerilmektedir. Eser bir kavramsal çerçeve çalışması olup, Bütünleşik İş Sistemleri Çerçeve Çalışması (BİSÇ) ismindedir. BİSÇ, İS'e ait tüm önemli varlıkları betimlemeyi amaçlamaktadır. BİSÇ, bu amacı farklı disiplinlerden gelen tüm kavramları uygun seviye ve boyutlarda harmanlayarak sağlamaktadır. Bu özellikler, BİSÇ'e bütüncül, çok disiplinli ve sistematik yaklaşımlar vermektedir. Bu durum, BİSÇ'e, tek yapı görünümü içinde benzersiz Sosyo-teknik İş Sistemleri Düşüncesi getirir. Bu yenilikçi özellikleri ile BİSÇ'in kuruluşlara, uygulayıcılara ve araştırmacılara etkin kılavuzluk edebilecek niteliktedir.

Bu çalışma, sorun kümesi analizi, literatür atarması, BİSÇ tasarımı, değerlendirilmesi ve tartışması adımlarından oluşmaktadır. Sorun kümesinin, farklı formattaki çeşitli mevcut kılavuzlar yardımı ile detay analizi gerçekleştirilmiştir. Aynı zamanda, derinlemesine araştırma ve uygulama yazını incelemesi yapılmıştır. Bunlar ile somut bir bilgi birikimi sağlanarak, BİSÇ'in tasarım ve değerlendirme tabanı oluşturulmuştur. Bu taban üzerine, günümüz iş kavram ve eğilimlerine uygun olarak BİSÇ inşa edilmiştir. BİSÇ'in değerlendirmeleri, Bilişim Sistemleri Araştırma Tasarım Kılavuzu betimsel, analitik, deneysel ve gözlemsel yöntemleri ile gerçekleştirilmiştir. Nihayetinde araştırma kesinliği ve katkısı ile gelecek çalışma önerilerini içerek tartışma ve sonuç sunulmuştur. Bu çalışmanın, bahsi geçen eksiği etkin ve verimli bir şekilde tamamlayarak, hem sanayi hem de akademi için çok faydalı olacağına inanılmaktadır.

Anahtar Kelimeler: Bilişim Sistemleri, Mühendislik Yönetimi, Sistem Yönetimi.

dedicated to ...

***Op. Dr. Solmaz Özalp**, as amaranthine as her name.*

a unique medium and very special means for the divine light and love,

an exposure of the meanings of the holy existence and oneness.

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LIST OF ABBREVIATIONS AND ACRONYMS

BP	:	Business Process(es)
BPD	:	Business Process (Re-) Design
BPI	:	Business Process Improvement
BPM	:	Business Process Management
BPR	:	Business Process Re-engineering
EA	:	Enterprise Architecture
IS	:	Information Systems
IT	:	Information Technology
ICT	:	Information and Communications Technology
OS	:	Organizational (Re-)Structuring
PI	:	Process Improvement
TA	:	Technology Adoption
WS	:	Work System(s)
WSF	:	Work System(s) Framework
WST	:	Work System(s) Theory

CHAPTER 1

INTRODUCTION

The success of a corporation is mostly measured by the level of Business Value Gain achieved. The gains may be in the foms of increasing the market share or revenues, enhancing customer satisfaction or conformance of the products etc. This value gain is the highest Business Goal for Corporations regardless their types; academic institutions, industrial corporations, or even government agencies. In order to hit these goals; creating the Work Results in shorter time, with less effort and cost, conformance to quality, efficiency and effectiveness of activities and their alignment to business goals are sought [1], [2].

During these endeavors, corporations expolit various disciplines, such as; Engineering Management, Technology Management, Business Administration, Finance Management. These disciplines are mostly executed individually or jointly in a weighted manner. Some are overestimated and others may be either underestimated or totally skipped. In fact, all of these disciplines should be considered in a balanced way. To achieve this, corporations aim for reaching a holistic vision for their business management. This kind of management harmonizes interdisciplinary approaches in a balanced way with systems thinking. This philosophy has lead to the *sociotechnical work systems thinking* concept implemented in business of today, regardless the application field or business context [3].

All these developments help to analyze business as a Work System (WS) with its specific components, views, levels and relations, accompanied with boundaries, environment and context. For business value gain and business goal reaching, corporations execute different WS activities based on the various disciplines mentioned. The success of these efforts is not always as high as expected. In the following Sections of this Chapter, in regards to the problem domain, the solution domain and the gaps in between are analyzed. Based on this analysis, framework of this thesis is presented.

1.1 PROBLEM DOMAIN

1.1.1 Failures

Today, WS activities, like System Implementation (SI), Technology Adoption (TA), Business Process Management (BPM), Corporate Reorganization (CR), or Enterprise Architecture (EA) are executed very commonly. These efforts are neither new nor few, but their success rates are not high and the ratio of failure stories regarding these efforts is extremely high. The reasons for these failure stories are mostly stated considering technical constraints and requirements in a highly biased way. Additionally, a lack of detailed analysis, assessment, planing, and consideration of non-technical factors for WS efforts is recorded [1], [4], [52]. In Business Conduction, these deficiencies can be frequently seen by corporations' fast market trend follow ups and direct customer request consents [5].

1.1.2 Medium

Non-technical factors are related with management and organization; such as management commitment, staff involvement, resource allocation, pilot projecting, setting goals, and model definition. Analysis, assessment and planning of these technical and non-technical factors together need Socio-technical Work Systems Thinking in business conduction [65], [66]. Business conduction uses various disciplines. They are instanced as, Systems Engineering (SE) [6],[7], Portfolio / Program / Project Management (PM) [8], Quality Assurance (QA) [9], Specialty Engineering [10], Process Improvement (PI) [11], Business Process Re-engineering and Management (BPR, BPM) [12],[13], and many others being used in today's business [83]-[87]. Based on these, there are plenty of concrete lessons learned transformed to well documented best practices. These are open to WS researchers and practitioners and may be used for WS Guidance.

1.1.3 Existing Guides

Many frameworks, models, best practices, body of knowledge or standards exist to guide corporations and users during these mentioned efforts. Most known samples may be given as : CMMI Models [11], ISO Standards [6],[9],[10], INCOSE Systems Engineering Handbook, Systems Engineering Fundamentals of the Defense and Acquisition University, NASA Systems Engineering Handbook, ESA ECSS Standards Framework, IEEE/PMI PMBOK [8] and OPM3 [15] and last but not the least, ISACA COBIT and Enterprise Models such as TOGAF's, DODAF's and Zachman's [16], [17], [18], and frameworks proposed by academics for WS research and practice [14], [19], [20], [21]. They are mostly domain specific and highly textual. Mapping and relationing of the entities are left to the users. Their approaches are biased with one perspective mostly, making them either technical, or project or process oriented. These perspectives are not well harmonized with relating their instances or entities. Hence, they are unable to support WS activities with a holistic interdisciplinary systems approach [53].

1.2 SOLUTION DOMAIN

After analyzing the problem domain and related work detailed in Chapter 1.1, at this point it is found out that, a proper solution should encompass designing a guide that governs all necessary disciplines used in WS, harmonizes these disciplines and their instances with systems thinking, and presents at a holistic approach with high level conceptual form in order to guide researchers and practitioners during their WS activities. Such a guide would enable users to analyze any business as a socio-technical WS, comprised of several subsystems interacting with other. In addition, such a guide would also widely extend the usage of guidance in WS.

1.3 GAP ANALYSIS

At this point, it is valuable to define the chasm between the problem and solution domains. This definition will set the gap analysis with the aim of forming the base for the objectives, scope, content and rationales of this dissertation work, which are presented in detailed in Chapter 1.4. Gap Analyisis is performed by the comparision of the related work to solution domain. In this context, three main gaps are seen those can be summarized as follows:

- ***Lack of Interdisciplinary Approach :***

There is an an unbalanced ratio of social and technical aspects during the Decision Making in WS Activities. These decisions are mostly set according to technological trends [1],[3],[4].

- ***Lack of Systems Approach :***

When the existing guides and related works are examined carefully, it may be seen that specific characteristics of the sole entities are taken into account more prominently than the relations of the entities forming the system, thereby causing the loss of balance [3],[4],[36],[37].

- ***Lack of Holistic Approach :***

In all business environments, a proper institutional management for the whole corporation activities is lacking. Utilizing Processes, Projects, and Products in a harmonized way, like conducting an orchestra is a big demand. Unique High Level views are lost [3],[4],[34],[35], [39].

Finally, as coverage for these three main gaps, there is a deficiency of suitable guidance to cure this lack [1], [4].

1.4 DISSERTATION WORK

1.4.1 Objective and Scope

The objective of this thesis is to propose a solution to remedy the ill-natured failures in WS Activities. The proposed solution is achieved by creating a novel framework as a research design science artifact. The artifact's aim is to guide corporations, and users, during any WS pursuit, especially in Information Systems and Engineering fields.

1.4.2 Rationale

There is no standardized common-sense set of lessons learned, best practices, neither leading guidelines, nor frameworks for the implementers and researchers to guide them during their WS activities against failures in the related markets. For this reason, it is also believed that the HWSF would also be a strong supporter for the development of a holistic interdisciplinary Work Systems Body of Knowledge. The research on WS (or even, more generally on Systems) has mostly focused on the innovations in and limits of Technology and closely followed by Information concepts debated under Systems and Engineering Sciences.Organizational and Management concepts are mostly debated under Financial and Administrative Sciences. Actually, both organization and management are accepted in the academic world as a research area and introduced courses to many curriculums of undergraduate and graduate programs regarding Information Systems, Operations Research or Engineering Management.

Case studies and research results also show that the organizational issues are the most difficult causes of the failures in WS activities [1]. All these show the need of research and implementation work on management and organization issues in WS. In this regard, this work with its novel approach will also fill a gap in WS Research.

1.4.3 Content and Outline

The content of this dissertation work is; problem domain analysis, literature and practice search, gap analysis according to the findings, and design and evaluation of the artifact with the aid of the findings. . Discussion, conclusion and future work proposals will finalize the work. This dissertation work's outline is formed with respect to Hevner's Design Science Research Guidelines [14]. Chapter 1 is the Introduction chapter, and defines at a high level the need and the proposed solution offer of the creation of an innovative and purposeful design artifact for a specified problem domain. The detailed analysis of the problem domain, comparative analysis of the existing solutions within the domain and the summary of the research is given in Chapter 0. In Chapter 3, the detailed definition and description of the design artifact is given. The evaluation of the HWSF is presented in in Chapter 4. The conclusion is given in Chapter 5, with necessary discussions and future work proposals.

There are also five appendices dedicated to three proceeding articles presented in conferences and two journal articles prepared for the Engineering Management journals. These articles have been prepared throughout the life cycle of the HWSF and supported by this dissertation work.

CHAPTER 2

CONVENTIONAL BUSINESS APPROACHES

2.1 CONVENTIONAL VIEWS

The industry, technology and the Business Models have evolved dramatically, especially in the last two decades. This evolution influenced the lifecycles (LC) and Business Processes (BP) for sure. Still, the early lessons learned and models remain and actively used in today's industries and markets.

2.1.1 Lifecycle Views

Especially after the Industrial Revolution, there has been a need to define the processes of business to conduct the business in the right way. Process design and improvement efforts have never lost importance, but their names and scopes may have changed. This effort was not only for increasing the efficiency and effectiveness of the internal processes, but also performing seamless flow of work with external participants. The conventional LC view is a cascaded depiction starting from planning to final stage of utilization and retirement. The Waterfall LC (WF LC) is based on this logic, as shown in Figure 1, [22].

Figure 1 - Waterfall Life Cycle

2.1.2 Process Views

Deming's "Plan Do Control Act" cycle is shown in Figure 2, [9]. It is still used today for business activities, especially for BP activities together with WF LC Model. It is important to note that PDCA has its roots from Bacon's Scientific Methodology, and many software lifecycle models are still just derivative reproductions of WF LC Model. Most of other new process or LC definitions are

also based on or derivatives of the former business models and definitions. These former models were defined during former ages when former technologies were utilized. Hence, the newer models based on or affected by these former models may be staled for today's business environment. This may be the root cause why software developers cannot get on with the WF LC Model.

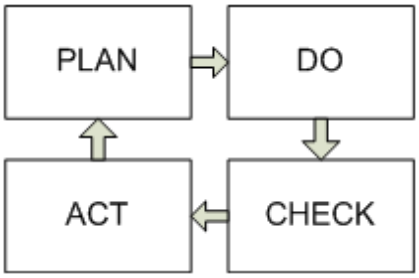

Figure 2 - Demming Cycle

2.1.3 System Views

Systems are important in business, academic and daily life as they serve to reach the goal in an orderly and organized way. They increase efficiency, effectiveness, quality and satisfaction, and decrease cost, discrepancy, latency and risks. Hence, it is vital to design and plan systems carefully. This importance becomes more prominent in this age of technology, because the Systems and their Results are less concrete than ones in prior to the technology age. They are less concrete because the System Results are now dramatically more based on information in digital or service forms. Information is still concrete enough to perform BP. Products of earlier periods, such as machines or chemical products, were more observable and controllable during all phases of production process and product lifecycle. The same is true for BP as well. Today, the analysis, planning, execution, test and integration phases of production process are no more cascaded and independent as in former industries or businesses used to have. They are very overlapping and feed back to each other. Hence, the importance of analysis and planning phase becomes more significant because of the changes in products and processes.

Among various systems, Work Systems (WS) are roughly defined as Systems including humans, information and equipment to perform a specific work with methods, measurement and management [23]. Today various forms of WS with different configurations and layouts are being used during business conduction progressively. They all support seamless and fast workflow of information and materials, observability and controllability of the entities and transparency of the BP. In Table 1, some samples for such Systems are given [19]. Formerly, they were perceived as only technical infrastructures composed of platforms, tools and applications. But, with the aid of the WS Approach, they can now be considered as Systems comprised of technical (methods, measurement and equipment), non-technical (humans), and hybrid (management and information) entities [20]. For this

reason, WS should be considered as Socio-technical Systems and analyzed using both Technical and Non-technical Perspectives [4], [24], [65], [66].

Table 1 – WS used in Business

System Type	System Sample
Enterprise Systems	Enterprise Resource Planning Systems
	Supplier Change Management Systems
	Customer Relation Management Systems
	Fully Automated Systems
	Self Service Systems
Functional Systems	Sales and Marketing Systems
	Manufacturing and Production Systems
	Finance and Accounting Systems
	Human Resources System
Management Systems	Executive Support Systems
	Decision Support Systems
	Management Information Systems
	Transaction Processing Systems

2.2 CONVENTIONAL GUIDE FORMATS

The conceptual versions of systems and their elements to be built are vital aids, especially during the analysis and planning phases of system. These conceptual versions are mainly frameworks and followed by models. They do strongly help to design products and processes carefully and clearly in order to eliminate failures and risks at the earlier phases and stages. In the systems of today, this elimination is either impossible at later stages or only possible with extremely high costs and risks, which might lead to direct cancellation of the system rather than modification of it [19], [20].

2.2.1 Frameworks

Frameworks are simply the skeleton or structure, on which the system will be designed or built and then developed with details and enhancements. They are the conceptual, abstract and even represent ideal versions of the concrete systems. Hence, they are like the blueprints of the circuits to be designed in electrical

engineering or structures and machines in mechanical engineering. Alter defines frameworks as brief set of ideas and assumptions for organizing a conceptual system in a generic way [20]. In this way, frameworks help a lot to design systems by identifying the related topics and relations, which will then be the concrete elements and methods of the systems. Frameworks are widely used in research, because they are useful in presenting an approach to an idea or a solution for a specified problem domain. Frameworks are mostly taken as intermediate theory to connect to most of the aspects of work under investigation.

Frameworks are like road maps that guide the implementers of the related work and they are coherent to empirical research. So frameworks are very valuable as an initial step before starting a research or solution proposal to a problem inquiry, which will continue to guide with its possible revisions throughout the lifecycle untill the solution is reached. Frameworks are an important element of the knowledge base through which WS research and implementation can be executed and finalized successfully [20]. When project failures and lessons learned on Software Projects, Information Systems and e-Business Initiations are reviewed, the vitality of this point is clearer [89]. Lack of systematic approach, careful planning and guidance usage in industry, and lack of academic and research support for these issues are observed as the main root causes of the failures in WS activities [4].

2.2.2 Models

Models can be created by embedding the representations of the entities and relations forming a specific interest into the structure given by a reference framework. Hence, models are not as conceptual or generic as Frameworks. They are the imitations of a reality without all details. Hence emphasizing some features, and underestimating or even overlooking some other features of the related concept is normal in modeling [20]. CMMI Institute's Capability Maturity Models like CMMI for Development or Acquisition, and Project Management Institute's Organizational Project Management Maturity Model, OPM3 are valuable instances for models.

Architectures have been residing as organizational meta-models for enterprises or institutions [18], [88]. Department of Defence's Architecture Framework, DoDAF and The Open Group Architecture Forum's framework TOGAF are two of the most popular samples for architectures, which are somehow, routed from Zachman's Framework [16]-[18].

2.2.3 Standards

Standards are strong tools for the users in business and academy. They guide users to analyze a concept by serving a simplified imitation of that concept. They are not high level definitions like the former ones. They may have embedded frameworks, models and architectures. They have more textual definitions, rather than high level of graphical definitions, in contrast to Frameworks or Models, . They claim to give a complete 'what to do' definitions. These are the definitions for the process and activities based on Best Practices, Common Usages and Lessons Learned in the

specific field. They leave ‘how to do’es to be tailored and defined by users, in order to be non-specific and non-restrictive. This situation makes them more normative, informative and definitive. Descriptive, prescriptive and explanatory features are left to specific guidelines created within the corporation. These features yield these guidelines to be field or application specific.

Existing Standards for technical, engineering, organizational and management processes are well defined or adopted by bodies like ISO, IEEE, ANSI, PMI, INCOSE and ECSS. CoBIT and ITIL are also good examples for standardization for best practices in IT field. And mostly these best practices are first compiled in Body of Knowledge format than transformed into Standard, as in the case of PMI’s PMBOK, which had been adopted as standard later by both ISO and IEEE.

As mentioned in the abstract and introduction chapters, today industry is still struggling for efficient WS Activities, which is conformal for process maturity, quality assurance, and project management. These conformances are also mentioned explicitly in the customer agreements. In order to achieve these, corporations, enterprises or groups either follow some models and standards or create their own standards framework, as European Space Agency, ESA did by the aid of European Committeee on Space Standardization, ECSS. Combining these well known models and frameworks in Turkey and neighboring region is also new aspiring trend.

There are plenty models, best practices or standards followed by corporations to guide during these mentioned efforts. Mostly known samples for these ones can be listed as:

1. For Systems Engineering;
    a. International Standards Organization’s ISO 15288/12207 Standards,
    b. IEEE’s 1220 Standard,
    c. INCOSE Systems Engineering Handbook and SEBOKwiki
    d. Defence Acquisiton University (DAU)’s Systems Engineering Fundamentals (SEF),
    e. NASA Systems Engineering Handbook,
    f. ESA ECSS Standards Framework…
2. For Process and Quality Assessment;
    a. Carnegie Mellon University Software Engineering Institute’s Capability Maturity Model Integrated, CMMI,
    b. ISO 15504,
    c. ISO 25000 SQUARE…
3. For Project Management;
    a. IEEE/PMI PMI PMBOK,
    b. IPMA Project Management Framework,
    c. APMA

d. UK Governments' PRINCE2 Model…

4. And last but not the least,

a. ISACA COBIT and ITIL Frameworks for IT Assessment, and

b. Enterprise Models such as ARIS, TOGAF, DODAF and Zachman…

Each guide claims to have a specific, unique and effective way of understanding for corporation management in their markets, where all the others are lacking. Actually, this is true, because an entity that is explained in one guide is either underestimated, or market specific or totally jumped in another one. Besides, when their contents are seriously analyzed comparatively, they seem to have a large common part and are very similar, because, each guide has a content spectrum that is roughly similar to System LC. In this spectrum, the main start and end milestones are Requirements Analysis and Customer Acceptation. In between, design, develop, verify, validate and acquire phases are inserted in various ways with different weights. And this lifecycle is mostly rooted from either MIL_STD_438 or EIA/IS_632, which are obsolete parents of the existing models of today.

The first group has more of a systems engineering view with an engineering management dimension. They take systems engineering as a product lifecycle and define this lifecycle with specific phases and their processes. The second group claims to be more process oriented, whereas the third tries to give a project oriented view by the nature of its name. Most of them have similar contents. Major differences between them may be summarized as follows. CMMI is more process oriented. ISO 15504 more SW oriented, as it does not only support 15288, but also 12207. Another project management model, IPMA, again mentions the same main fields, but with more stress on cost and human resources management with respect to PMBOK. ITIL and CoBIT are other assessment frameworks which resides more isolated in Information Technology field. Also the so called Enterprise Modeling offers could not penetrate the market and seemed to be more conceptual architectures for technology and infrastructure.

2.3 WS GUIDES OF TODAY

The samples given for frameworks, models, standards, architectures are the outcome of the literature survey on the WS research and practice. They create a big set with wide ranges of status (active, revised or obsolete), types (framework, standard or model) or forms (textual, graphical). They are valuable alternatives for WS issues. Still, they are not possessed well enough by the researchers and practitioners in the WS field. One of the main reasons is their specific strengths on some perspectives and impotency in others. The second is their out-of-datedness with respect to today's business context, where processes, lifecycles, results and enterprises are in transition [25]. Third, fuzziness in the aimed level of conceptualization of, characteristics, qualities and traits; lack of clear demonstration and definition for the necessary dimensions, entities, relations are also observed in most of the existing guides. All these cause difficulties for participants to understand and apply the concepts clearly [19], [20]. When, a big set of existing guides is

evaluated with respect to these 3 criteria mentioned, the works of Alter, Laudon, Hevner and Unhelkar are chosen to be the knowledge foundation of this work with their Conceptual Framework features such as Visual Depiction, High Level Definitions, balanced and relatively actual contents [20].

2.3.1 Work System Framework (WSF)

The very famous work centered analysis framework, WSF revised by its creator Steven Alter is given in Figure 3 © [28]. WSF included seven main components: the customer, the products and the services, the process and activities, the information, the technology and finally the participants. The customers are the people who use and receive direct benefits of the products and services produced by the work system. Customers may be external, internal customers, end-users or other stakeholders. Products are combination of physical things, information and services that work systems produce for their customers. The reason of the existence of the work systems is to produce these products. In this framework, under customer and product, there is a group formed by the four elements, those are; Business Processes, Participants, Information and Technology. This group forms the WS Core. In the WSF, WS Core is defined as the system where the work is done [20]. Business Process is defined as set of work steps or activities performed within the work system in this framework. Information is the information used by participants to perform the work. Technology is the hardware, software, systems and other tools and equipment used by participants to perform the work. Participants are the people performing the work.

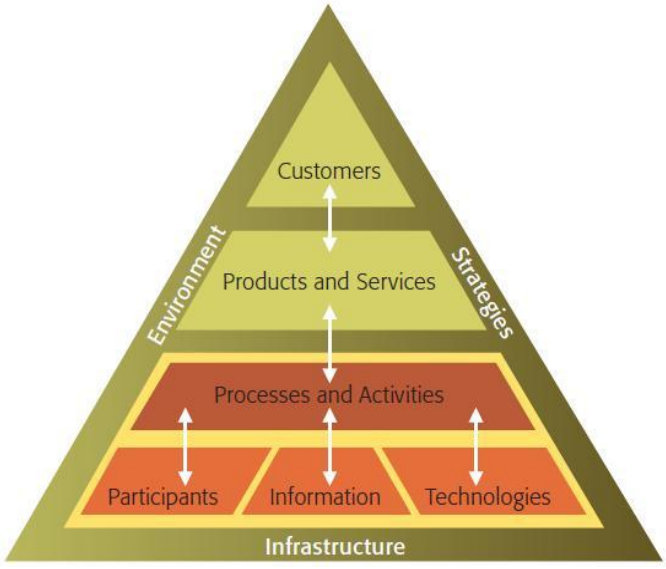

Figure 3 - Work System Framework

WSF has been a base for the usage of industry, regarding the design, implementation and evaluation of the WS. It also served as a powerful tool for the research on Information Systems as a specific sub-concept of Work Systems, and Management Science or Industrial Engineering fields [26], [27]. Much literature on the research and practice of Systems and Business Process has referenced WSF as a

foundation for their work, and even improved on it. For example, Mansar and Reijers had included Organization concept into WSF as an improvement [2].

2.3.2 IS Perspectives Framework

Information Systems has already invaded our professional and daily lives for decades now. Their wide adoption and usage is getting much broader, while their sophistication is also increasing dramatically. While IS was seen as tool for management before, today research and industry is working on emerging concepts mainly formed with the usage of IS. Examples of these emerging concepts can be given as mobile enterprises, networks for cars and many other more. The concepts and the applications of IS in academic literature are very well defined as interrelated components collect, retrieve, process, store and distribute information to support organizations. From this point, IS becomes a strategic tool for organizations to support their decision making and work control. The aim of any business is to gain value. The importance of WS, hence of IS, as a strategic tool, gets clearer as it serves business for increasing efficiency and enhancing effectiveness [19]. Laudon has defined IS with three main perspectives, namely Organization, Technology and Management, as shown in Figure 4 © [19]. This depiction is highly conceptual and mentions only three main elements of IS. Today, there are still debates on these elements, their borders, interactions and their overlapping regions. But this perspective has an important role on understanding the IS as a work system and its sub-elements of information technology, computer science and other engineering fields within the technology dimension of IS.

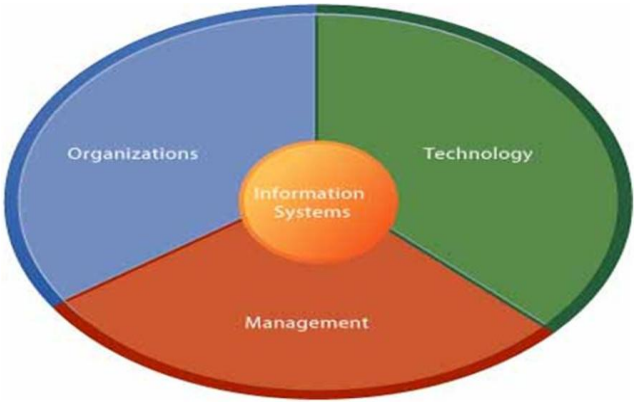

Figure 4 - Information Systems Perspectives Framework

According to this framework, Organization is defined as a social, stable and formal structure taking resources from its environment and processing these resources to produce outputs. Organizations have people, structure with business process, policy and culture. With these elements, two views analyze organizations; technical and behavioral. Technical view takes organizations in an input, process, and output view. Here inputs are labor and capital, outputs are product and services, and process is the transformation of inputs to outputs via any business processes and supporting methods; whereas, behavioral view defines organization as a collection of rights,

privileges and responsibilities balanced over a period through conflicts and resolutions. Laudon also relates these two views to IS [19].

Management, in this perspective is explicated as more than managing existing processes, such as making sense out of the situations faced and perceiving the challenges in business environment, setting organizational strategies and making strategic decisions for these challenges, developing corrective action plans to solve organizational problems and achieve success by allocating resources, coordinating work. Enterprises have 3 main Management Levels; as Senior, Middle and Operational. They are additionally shown in Levels in a Firm depiction IS Perspectives FW as shown in Figure 5 © [19].

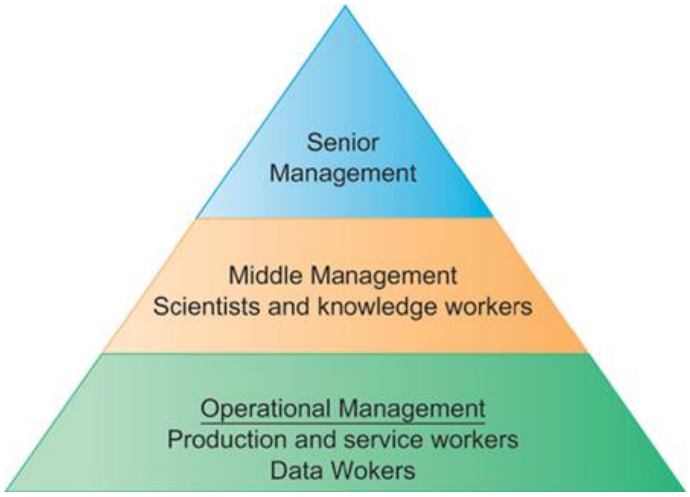

Figure 5 - Management Levels in Enterprises

By the aid of this perspective, the organization and management dimensions are having more highlights, and IS is able to be taken as a socio-technical system. Now it is widely spoken that the success of a IS adoption is strongly related with technology, infrastructure and also the adoption and governance. The happiness of the users and customers, usability of the system and the effectiveness and the efficiency of the processes due to the users, actors and customers are good samples for the socio-technical research areas today. The interdisciplinary structure of IS given in Figure 6 © [19], shows the research demand for information systems on the fields of organizational and management sciences, where technical and social approaches is needed and utilized [4], [19]. In accordance with the definition of IS, Laudon briefly defines information as formed data which is meaningful and useful to users. After relating information with data by definition, he describes data as raw facts representing events. Moreover, he defines the evolution line of data to information, knowledge and wisdom briefly. This hierarchical representation of information is actually dual with the Management Levels presented in the Organization of the Corporation. In these Management Levels different forms of the Information is used. Data Workers operate with data at the Operational or Transactional Management Levels. Knowledge Workers use data and information to create knowledge (which can be tangible and intangible) to the organization at the middle management level.

Senior Management Level employees work with structured and highly sophisticated level of data, to perform long term strategic decision making [19].

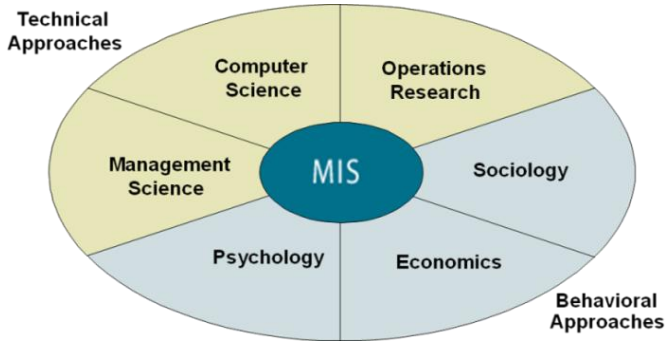

Figure 6 - Interdisciplinary Nature of Information Systems

2.3.3 Mobile-Business Transformation Framework

Unhelkar had proposed a set of frameworks guiding the transition of mobile enterprises [21] . This work mentions the important points while transforming the conventional enterprise to mobile enterprise. Still, it has valuable tools for guiding this work during creation of the novel framework for implementing and adopting IS in business conduct.

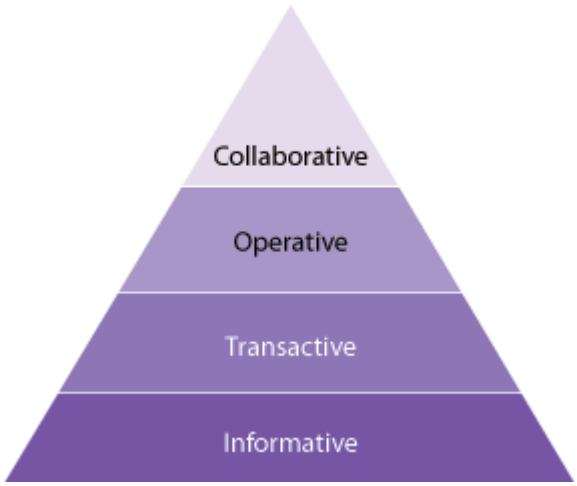

Figure 7 - Business Information Levels in MBTF

In his work, Unhelkar differentiates levels of business utilizing the mobile services. According to him, there are four levels which are informative, transactive, operative and collaborative as given in Figure 7 © [21]. According to this pyramid, in the the lowest layer, information is utilized in business communication for informative purposes, i.e providing information from one peer to another. It is a one way direction of information flow. Security requirement level in this layer is minimum compared to upper layers. Today, this is the widest layer, as the information flow is

excessively informative in business conduct. In transactive layer, the flow of information is defined as multiway between the users in the business, like order and acknowledgement processes in money transactions or payments. Here the security level increases, although the users of the processes are known to the business. This layer may also utilize the wider informative layer. In the third layer, operative processes are conducted which are internal core processes for any business such as inventory management processes. Finally, the collaborative layer comes to the scene depicting the cooperative work of the parties in order to achieve the business value.

This model is very useful in seeing the position of information in new business models. The products are more service and information based. Also information today is not only an input nor control value for output/result production, but also a real semi or final product with different levels of sophistication. This situation is somehow dual with information leveling in Laudon, from data, to information, knowledge and wisdom.

2.3.4 IS Research Framework

Hevner presented a conceptual framework also for understanding, executing, and evaluating IS research. In this work, behavioral-science and design-science paradigms are well combined. Hevner defined their main intention as informing the community of IS researchers and practitioners of how to conduct, evaluate, and present design science research. IS Research Framework is given in Figure 8© [14].

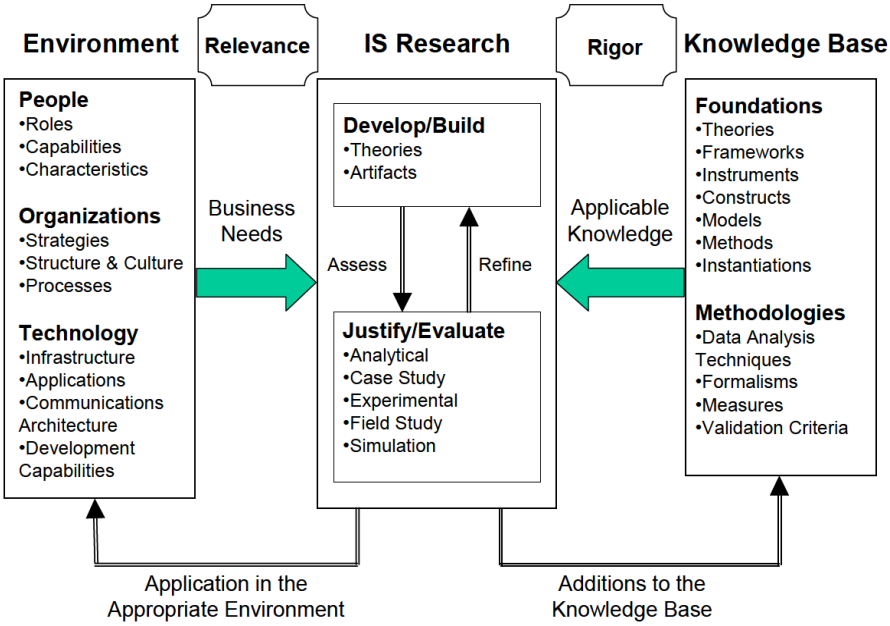

Figure 8 - IS Research Framework

According to this framework, environment defines the problem domain. The goals, tasks and opportunities shaping the business needs are all in this environment. In the Environment, these facts and events may be turned into business interests by the

People settled in the Organization, with respect to their roles, capabilities, and characteristics. Business needs and interests are assessed and evaluated within the context of the business. *Business Context* is formed by organizational strategies, structure, culture, and business processes. They are situated with the existing Infrastructure, Applications, Communications, and Development Capabilities in the Technology Dimension of this framework. The combination of the People, Organization and Technology is to solve business problems and propose solutions to business needs.

Hevner's IS Research Framework is valuable for showing as many entities as possible in one high level descriptive conceptual framework. It is also important to propose such a FW to IS domain from academy, in addition to other FW proposals those are more industry oriented. These points would aid IS Theory and enhance Systems Thinking for WS activities, rather than technical assets perception. Although the concepts given in this work is extremely valuable, their allocation and relation are weak. Mentioning organization and knowledge foundation clearly is a very strong side but still, clear and rich dimensioning and leveling is lacking.

2.4 SUMMARY

The conventional views designed with former ages' technology, process and culture do not answer the needs and trends of the Business Conduction sufficiently any more. They need serious revisions with respect to the Business Contexts of today. The conventional guides in various formats are either field or discipline specific, or non-systematic, non-holistic, or lack of suitable conceptualization level.

The selected frameworks are good alternatives to guide WS Activities. Still, they have serious deficiencies when analyzed in detail with respect to the HWSF Goals criteria. These weak points can be improved and harmonized with their strong sides for designing a holistic interdisciplinary sociotechnical systems thinking WS Guide, with additional support of existing disciplines and theories [29], [30], [31], [32].

CHAPTER 3

CONTEMPORARY BUSINESS CONTEXTS

The Disruptive Technologies of today with various tools and infrastructure have changed the methodologies and results of today's work conduct styles. Especially the fast convergence of Information and Communication Technologies (ICT), and their fast adoption has one of the major roles in this paradigm shift. Collaborative work and cooperation had always been a great demand in human history in any era, in any business. This demand were not well mentioned enough in former WS FWs or models, as it is more formed of intangible knowledge which may quite hard to depict when compared to more concrete nature of Products and Processes.

3.1 BUSINESS VALUE MODELS

Today for Business Value, chain model is still excessively used. Chain model show a linear cascaded workflow from Suppliers to Customers. It may include other stakeholders like manufacturers, distributors and retailers with push or pull models as shown in Figure 9, © [19]. The feedback or interactive participation of the stakeholders is not clearly shown in this model. The business value acquisition of today can no more be represented with this model. The product or service needs interaction of the stakeholders for a resolution in common sense. The fast invasion and adoption of communication and information technologies to any market, their fast applications on business processes enabled this situation. This gave rise to the understanding of 'Business Value Webs', as shown in Figure 10 © [19], rather than Business Value Chains. This model is even more correlated with the 5 Competitive Forces of Porter, better showing the stakeholders collaboration.

Figure 9 - Business Value Chain Sample

3.2 STAKEHOLDERS

This ever existing collaboration demand is now more visible and more under discussion with the aid of fast changes in Business Environments, Models, Concepts and Contexts. Today, collaboration is actually much more than just the cooperation of two parties to produce a product for a customer portfolio. The responsibilities, functions and number of stakeholders have also evolved. They cannot be

summarized as Producer to Customer chain any more. Content providers, service providers and network providers are some of the current instances for this evolution. Also, Customers or End users became natural Stakeholders of the Value Model. They collaborate with others and aid tailoring of the Result in an interactive way [14], [19], [20], [21].

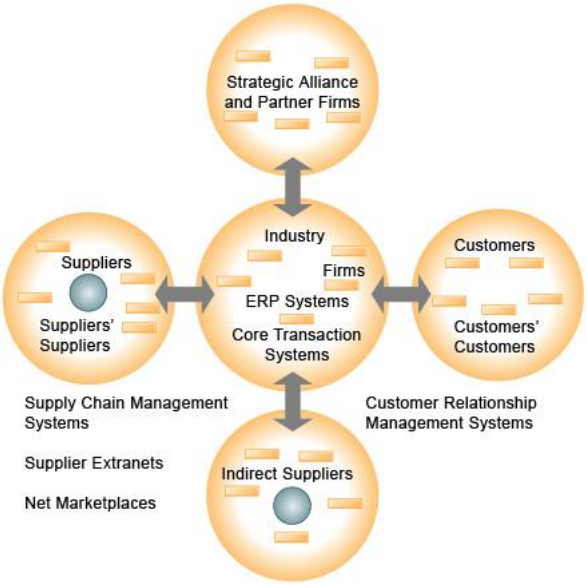

Figure 10 - Business Value Web Sample

Hence, evolution of the Business Value Model (Figure 10) aided the definition, visibility and collaboration of the Stakeholders and their constellation as given in Figure 11.

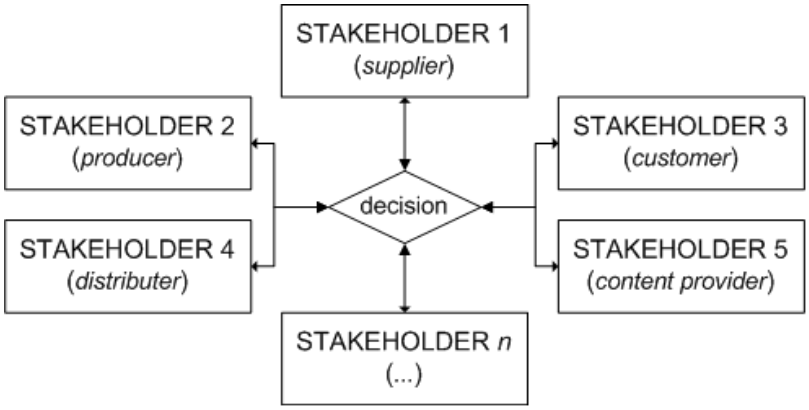

Figure 11 - Collaboration of Multi Stakeholders

3.3 PRODUCTS

Today in any business, the nature of the results output to markets are becoming more and more information and service oriented. This is due to the excessive

adoption of Systems in Enterprises and invasion of Disruptive Technologies, especially based on Information and Communication Technologies (ICT) in Business Processes. This is more evident in banking and entertainment markets. In developed regions, physical money is almost not used at all, due to enabled e-transaction services via credit cards, e-banking options etc. e-Commerce service is getting more widely accepted, and mobile commerce (m-Commerce) service is rapidly in use. Also today, different forms of information serve as end products especially in Research & Development market. Business Analysis and Feasibility reports or Conceptual Operation and Requirements Documents constitute the final results of many projects with limited scopes [51].

3.4 ENVIRONMENT, STRATEGY AND INFRASTRUCTURE

In WSF, Environment is defined as a surrounding to the WS Core. Strategy and Infrastructure accompany to Environment somehow. This situation is similar in IS Research FW as well. In others, these entities are either overlooked or slightly mentioned, but not depicted and defined clearly [14], [20], [21]. In parallel to technical developments, the Environment concept became obvious in Business. Context Aware computing and m-Business are the major examples for this. Environment is perceived as the surroundings external to the concept under discussion. Actually, Environment is more than that. It is where the Business Concept under discussion is elicited. This fact become more evident today, as the business is not having strict rules as before. New business rules are adopted even by the older markets. The analogy between Lean Management in heavy industry and Agile Methods in software industry is a good example for this. Business is shaped within the Environment more easily today. Environment forms the context for the business to be conducted. Business Models are formed within Business Environment according to the Business Context. On the contrary, Strategy and Infrastructure are internal to the WS Cores with different dimensions [19], [29]. All these entities are positioned differently in the existing guides. Clear definition and correct positioning for them is a concrete demand for WS works.

3.5 WORK SYSTEM CORE

The four WS Core entities of WSF and their interrelation had always been a discussion. In this sub-section, their definitions and positions with respect to existing WS Guides and Business Contexts is summarized.

3.5.1 Participants

In WSF, Participants are the people who perform the actual work. Accordingly, Incentives and Strategic Decisions, like Organization Structures or Product Innovation, are set by the Participants, especially from higher Management Levels. Then these are executed by all Participants from related levels. Organization Culture is shaped by all Participants of the Corporation. Hence, Participants are the concrete actors of the Business Processes to execute. Sometimes, the Technology components may act as the actor of some of these processes, but they always serve (human)

Participants as concrete tools to execute their Business Processes [14], [19], [20], [21].

Organization and Management are the instances of non-technical perspectives. They are more abstract with respect to the entities defined in WS Core, and without Participants they are not alive. This is the reason why explicit positioning and definition for Organization and Management dimensions in WS Guides are sometimes lost. In WSF, Organization is not mentioned at all, in order not to create an ambiguity between an 'Enterprise Organization' and a 'Work Organization in a WS'. To ease this blur, Mansar offered inserting Organization concept within Participants element in WSF. Laudon, explicitly mentions Organization and Management dimensions of IS, but the depiction does not lead researchers and implementers clearly enough about enterprise organization and management. Hevner and Alter mentions management concept verbally within the environment entity, without clearly defining such an important element in their frameworks [14], [19], [20], [21].

Today, there is a need to harmonize all the important offer of these views in one framework. But before this, all entities and dimensions should be revealed and updated with respect to the needs of today's business contexts. Without clear definition of Organization and Management as dimensions, definition and positioning of Participants, Structure, Culture, Infrastructure and others cannot be held in a proper way.

3.5.2 Information

In today's business, the ultimate importance of the any form of information is better understood by the aid of excessive usage of IS. Before, Information was taken into account just as 'data' to be utilized within the Business Processes, like the material utilized in Technological tools. Today there are various levels of information; such as raw data, information and even knowledge. The organized form of data, which is information, is actively being used in business by middle and lower management levels within Enterprise IS. Applying patterns, rules with regards to context forms knowledge from information. Knowledge and Knowledge Management (KM) is still a research field, and enterprises are investing on KM systems to transform their tacit or intangible knowledge to explicit or tangible in order to enhance the organization memory and culture and hence to gain value.

Various formats accompanying these levels of information are also in use. Hence, Information today is not only used within a business process as a material or a tool in unique format as was before. Information is used in, transformed into, and fusioned into several formats and levels, served as input, output or enabler to a process and may result as semi-product or end-product. Hence in the actual WS of today, Information is an important element as mentioned in Alter's framework, but overlooked in many others. Unhelkar's Business Process leveling is strictly related with the Information level utilized due to the strong emergence of services and information based products of the m-Business. There is a duality between this and

the levels of information and management declared by Laudon. With the increasing demand on Information and Information based Systems in business, definition and depiction of Information as a dimension is a must [14], [19], [20], [21].

3.5.3 Technology

Technology is the most concrete entity of a System. In all FWs discussed in this work (WSF, IS Perspectives FW, MTF, IS Research FW), there exists the concept of Technology either as an entity or as a dimension. For this reason, there are plenty of good definitions for it. This makes the research and implementation more available on the Technology concept of WS. Like Information, Technology can also play a role in business, as a tool, an end result or a semi-product. Most of the time, Participants tend to follow the Technology in setting Business Strategy or managing Business Portfolios, while leaving out the other dimensions and entities of their WS and Business Environment [14], [19], [20], [21].

Technology and its components are highly evolving today. In former decades, people were quite distant to it, and leaving them to be utilized by their experts. But today, by the aid of converging Information and Telecommunication Technologies, to tools have invaded the daily lives of people. Today, most of the mobile phones, tablets or similar tools serving the senior level managers are also used by teenagers and students as well. The Technology Dimension, with its highly evolving and life style invading nature today should be taken into account seriously and be well defined in WS Guides in order to aid the design and implementation of the systems successfully.

3.5.4 Business Processes

Corporations always look for effectiveness and efficiency in order to reach their Business Goals and gain Business Value. Activities regarding Business Process are the most common address for this look. The dictionary definition Business Processes is given as the series of related activities performed together to produce a defined set of results. Upon to this quite mechanic description, definitions with more sociotechnical visions may include people, information, resources and customers as well [2], [14], [19], [20], [21], [29].

These process activities may include, but not limited to, execution, improvement, re-engineering, etc., regardless of the business type. Commonly, they act as the major actors for business transformations as well. When the history of process activities is observed, it is seen that the formal start occurred in the heavy industry field. This field held firstly steel and chemistry industries, which are followed by machine and electronics industries. Emerging markets, like Information and Communication Technology, Aerospace and m-Business, have imported process definitions of the former ones. The enhancement demand on processes is explicitly valid for both relatively newer and former industries. History of the process activities shown in Figure 12 © [12], [13] is valuable for understanding BP. In this history, concepts like Total Quality Management (TQM), Six Sigma, BP Improvement (BPI), BP Re-

desing, BP Re-engineering (BPR), Material Requirements Planning (MRP), Manufacturing Resource Planning (MRPII), Enterprise Resource Planning (ERP), Customer Relation Management (CRM), Supply Chain Management (SCM) and BP Management (BPM) are met [12], [13].

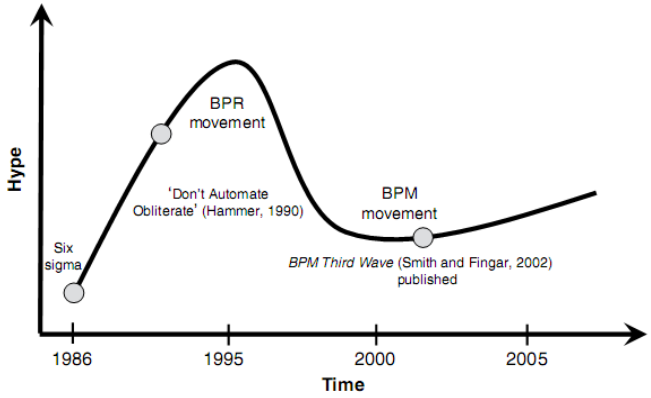

Figure 12 - Process Improvement History

According to this history line, BP concept was first highlighted with Six Sigma. Today, in academic literature BPR is defined as changing the total structure of the business processes as a holistic work, whereas, Business Process Re-design (BPD) is defined as the change of partial, even only one process within whole Business Processes architecture in an organizational structure. With the concepts that are mentioned above, like ERP, CRM, etc., Systems Thinking in Business are enabled. The current trend in the BP field, referred to as BPM, is observed to be the next big-thing in this area. BPM proposes a holistic approach to process activities by common management of BP definition, execution, improvement, re-design, and BPR. BPM's main difference with respect to former BP waves is handling BP with high attention on Participants and Organization entities, in addition to the Technical entities. With this vision BPM highlighted sociotechnical perspectives for process activities.

All these progress aided clarification of BP in WS. BP uses Workflows, Procedures, Tools and Materials to manage the business. Hence, BP is a bridge connecting Technology entities to other WS entities with its socio-technical features. Managing BP is more than executing specific processes or workflows solely, but coordinating various activities in a harmonized way, bringing governance [14], [19], [20], [21]. Accordingly, BP is given at the highest level of WS Core in WSF. In MTF, a special view is dedicated to BP in m-Business. IS Research FW shows it as an Organization entity and IS Perspectives FW, mentions it as a Management entity. On the contrary, Social Perspectives take it under the Technology dimension, as they refer techniques and methodologies as a part of BP, where knowledge may be embedded. As can be seen clearly, an ambiguity for the definition and positioning of a WS entity is apparent for BP in the existing guides evidenced by different perspectives with different weights [14], [19], [20], [21].

3.6 SITUATIONAL ANALYSIS

The adoption of disruptive technologies and the globalization of economy and work force have dramatic transformations on WS [54]-[59]. These transformations are visible on all entities, either technical or social, like Business Contexts, Results, Organization, Management, Technology and Information entities [60]-[64]. There are various guides available for the users for aiding their WS activities. The samples given for frameworks, models, standards, architectures are the outcome of the literature survey on the WS research and practice. They create a big set with wide ranges of status (active, revised or obsolete), types (framework, standard or model) or forms (textual, graphical). In this guides quagmire, any industry may easily become a model pursuer in order to improve their business and satisfy customer demands. Sometimes they have to purse more than one model as well. This is mostly because the models are mostly having one dominant view so a second even a third model is required to rectify other views in corporation management.

They may be frequently followed as a market trend by the users or corporations, without a real organizational demand, customer request or participants involvement. Hence, the results of such attempts may be quite far away from success, rather just a demand of certification for the Business Environment. Most of the time the aim for gaining these certifications is lost, certification solely becomes an aim, and even becomes a burden rather than improvement aid. Today some of them are more reputable and trendy than the benefits they claim to present. Most companies run for getting assessed according to ISO 9001, CMMI Dev. v1.3 or ISO 15504. These models are used for corporation certifications, whereas, INCOSE and PMI certifications reside more on personal purposes. All are sampled in Figure 13 © [33].

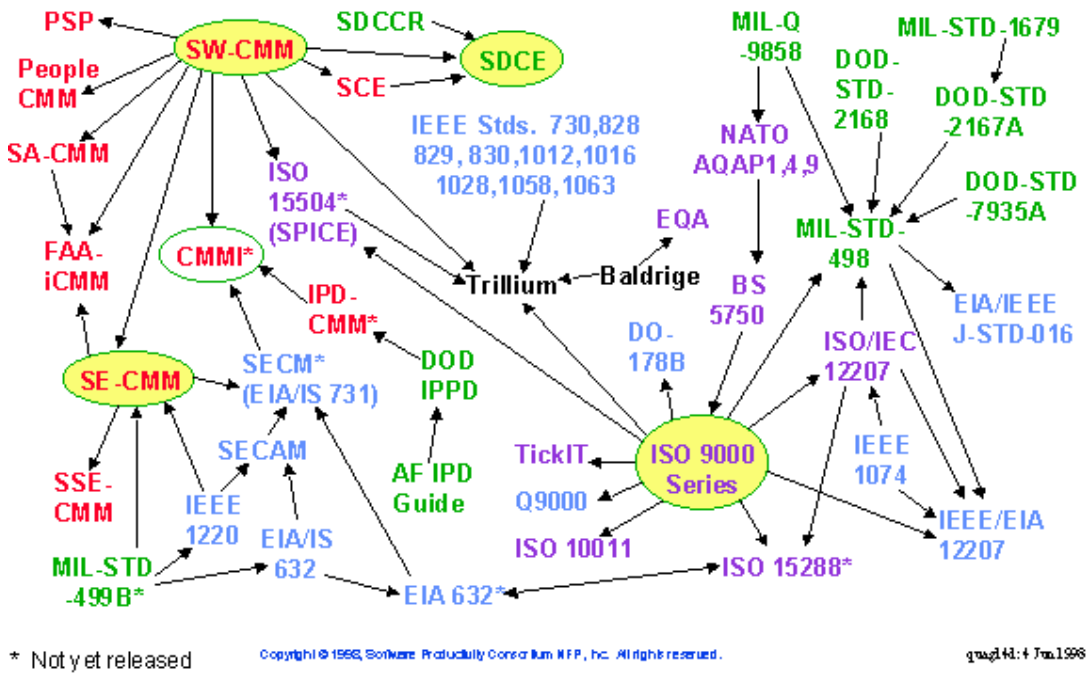

Figure 13 - Frameworks Quagmire

Still, they are valuable alternatives for WS guiding. But, they are not caught by the researchers and implementers enough. One of the main reasons is their specific strengths on some perspectives and impotency in others. Second important reason is the out-of-datedness of these guides with respect to today's business context, in where processes, lifecycles, results and enterprises are in continuous transition. Thirdly, the fuzziness in the aimed level of conceptualization, lack of clear demonstration and definition for the necessary dimensions, entities, relations are also observed in most of the existing guides. All these cause difficulties for participants to understand and apply the concepts clearly.

When this big set is evaluated with respect to these 3 criteria mentioned, the works of Alter, Laudon, Hevner and Unhelkar are chosen to be the knowledge foundation of this work with their Conceptual Framework features such as Visual Depiction, High Level Definitions, balanced and relatively actual contents.

From this point, it is easily seen that there is a lack of harmonized framework including all mentioned important dimensions and components of the existing models mentioned above. A framework depicting a holistic interdisciplinary big picture with systems approach is a clear necessity. These buddings help today to analyze business as a work system with its specific components, views, levels and relations, accompanied with boundaries, environment and context.

WS concept is a perfect application of Systems Approach in Business in order to aid the implementation of Information and Engineering Systems, and institutionalizing the Management and Organization activities in the Corporations. The WS are mainly mentioned and discussed in Management Science and Information System fields even before since 1980s. WS are clearly defined as the system in which human participants and machines perform a business process using information, technology and other resources to give the process output(s) for customer(s) [23]. IS is a very concrete and alive instance of Work Systems concept. There are numerous approaches for handling WS. Some take it with a strong technical dimension and analyze it with IT prominently. Some offer to take it with behavioral aspects also and takes organizational and management dimensions to the discussion as a socio technical system approach [28], [29], [30], [31], [32].

Hence, WS is a clear view for the Business in order to answer the questions raised by the evolving concepts in the Business Environment of today. Systems thinking paradigm would aid this need for analyzing the business as a Socio-technical Work System, handling the issues holistically, harmonizing the interdisciplinary fields of related entities enabling like portfolio, engineering, technology, quality, process and project management [34], [35], [36], [37]. With the clear harmonization of such approaches a guide, holding holistic interdisciplinary socio-technical system thinking, can be designed to redress the existing deficiency.

CHAPTER 4

THE HWSF DESIGN

The Scope of this research work is to fulfill the guidance demand for WS activities with respect to today's Business Contexts, by defining a conceptual framework. This framework covers all necessary interdisciplinary perspectives with related Dimensions, Components, and Levels with visual representation and high level definitions in Systems Thinking. For this reason, the artifact is named as the Holistic Work System Framework (HWSF).

The existing suitable guides in the literature have their own characteristics, with strong and weak sides. When each guide are put under Comparative Analysis in terms of scope details, it is easily seen that they are either not well supported by necessary disciplines in a balanced manner, or they are lacking entities demanded today, or they are having low usability due to the complexity or conceptualization level. This foundation formed by the literature research and comparative analysis directly aids the descriptive design and evaluation phases of the HWSF lifecycle [14], [19], [20], [21].

When the expansive set of guides mentioned in previous chapters is evaluated with respect to the domain requirements and deficiency causes the following approach is adopted; the foundation base for HWSF is formed using WSF [20] as the backbone element. Additionally, IS Perspectives Framework [19], IS Research Design Science Framework [14] and Mobile Enterprise Transformation Framework [21] are used as supporting elements.

The design phase of the HWSF lifecycle has a top-down approach supported by the harmonization of the strong sides, improving the weak sides, and finally adding unique enhancements of the selected 4 guides in accordance with today's business trends. It will first start with designating the habitat of WS, which is the *Environment*. This will also serve for defining the boundary of WS. Expanding on the Environment, Results, Stakeholders, WS Core are defined in detail. The allocation and interrelation of the HWSF entities with respect to Dimensions and Levels are developed [14].

4.1 ENVIRONMENT VIEW

In the HWSF, the *Environment* is not a strictly isolated external ambient external WS. The boundary in between is very dynamic and interactive [67]-[70]. In the

Environment, Stakeholders reside with their selected WS cores, interact with the Environmental factors and with other Stakeholders collaborate on the WS Result. This interaction and collaboration in the Environment influences WS operation. Market Trends and Regulations also reside in the Environment. From these, the resolution opportunities for the Business Needs are elicited and contexts, models and concepts for business are created, as in Figure 14, [19], [20], [29], [38].

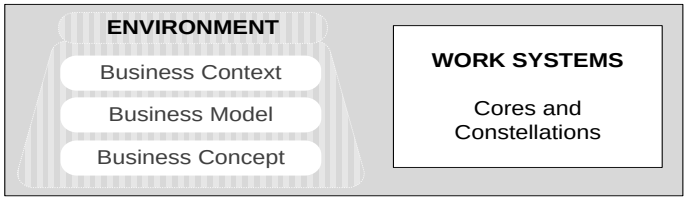

Figure 14 - WS and Environment

Business Context is roughly the characterization of the situation of a Stakeholder within the Environment [39]. To be more precise, it is a multi-dimensional realm in the Environment, with the competitive and regulatory issues for the Stakeholders. *Business Context* is the Systems Thinking base for the Business Conduction to define the models and concepts for business. *Business Models* are the relative positioning of the Stakeholders in an Environment for their collaborative business conduction, and the means of gaining value. Business Concept is the basic information or ideas on a new WS Result enabling the Stakeholder's advantage over its competitors within the Business Environment. *Business Concepts* are created by the interaction of Stakeholders in the *Business Environment* [72]-[81]. With respect to this external entity of Business Concept, Stakeholder's *Business Goals* are created internally within the Corporation. *Business Concepts* will be external to the Stakeholder, serving like an interface to the Environment [14], [19], [20], [29].

4.2 RESULTS VIEW

Today the Products are more information based and service oriented than before. In addition to final physical products, the WS output types extend to semi-finished / work-in-process or enabling / supporting products. These non-final physical products may even be the sole final results of many considerable WS and be input to other WS or end-users [71]. Prototypes, feasibility reports, preliminary design documents or mBusiness services may be given as examples for such Results of the collaborating WS Cores of the Stakeholders. Accordingly, in the HWSF, this dynamic nature of the *Products* in WSF is revised by name as 'Results', as in Figure 15. The new term is more conceptual and refers to all different forms of products existing in today's Business Contexts [6], [38] .

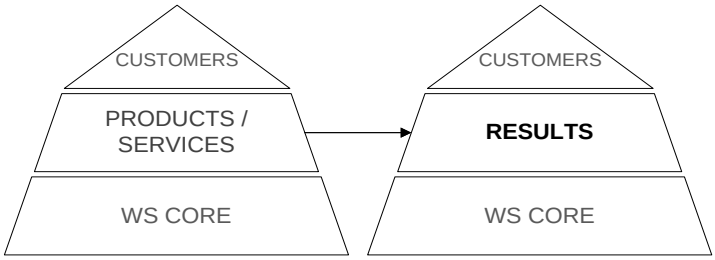

Figure 15 - Products to Results Change

4.3 STAKEHOLDER VIEW

Stakeholder is a person, corporations or group; having interests or concerns in an Endeavor. Endeavors can be in the form of a project, program, operation or other means with a specific goal and scope. Hence, Endeavors are the formation of WS, and their goal and scope are the WS Results. WS Cores owned by the Stakeholders are the actual place where the real work is done for the WS Result. For this reason in the HWSF, WS Core is represented by Stakeholder entity, as shown in Figure 16, [8], [14], [34], [82].

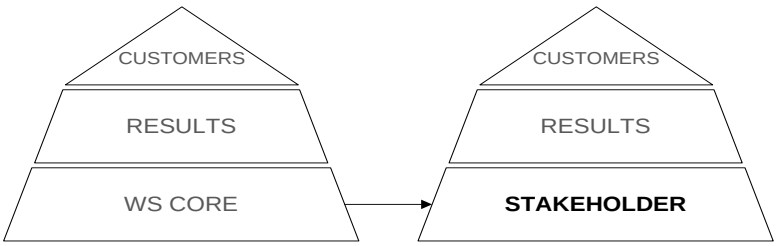

Figure 16 - WS Core to Stakeholder Change

In the changing Business Contexts of today, Business Model types had evolved from Business Value Chain to Business Value Web. With this evolution, the number of Stakeholders is no more limited to the two in WSF; Customer and Producer. Today, Stakeholders in a Value Web has a wide range, like Strategic Alliances, Suppliers, Service Providers, Manufacturers, Retailers and Distributers etc. These Stakeholders collaborate on the Results via their related WS Cores [19]. For this reason, in the HWSF, the Results entity is surrounded by several Stakeholders regardless their roles, as in Figure 17.

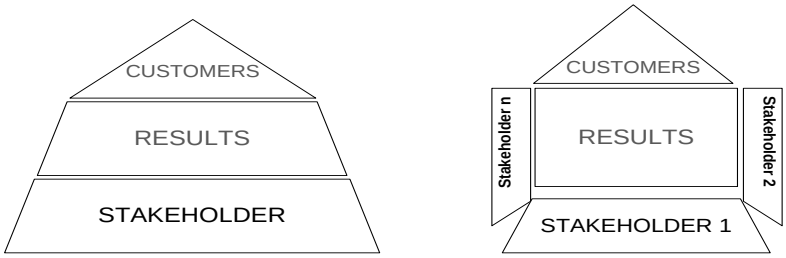

Figure 17 - Multi Stakeholders View

Today the Customers have stronger and more direct effects on the Results than ever before. In many cases they do not only feedback to enhance the next revision of the product, but also collaborate through whole lifecycle of the Result [15]. For this reason in the HWSF, Customers are also defined as Stakeholder which is also naturally collaborating on the WS Results in Figure 18.

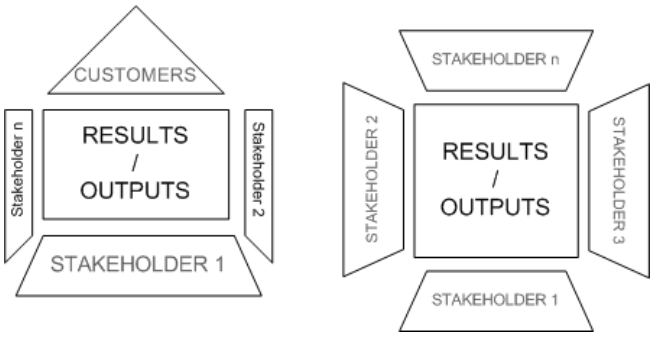

Figure 18 - Customer as a Stakeholder

Each Stakeholder may have several different core systems for specific functions. These systems form their internal WS Cores. The number, the configuration and the purpose of the WS Cores may depend on the organizational and managerial features of the Stakeholder. For example, One WS Core may be utilized for Inventory Management, the other for Supply Chain Management. A Stakeholder with multi WS Cores is shown in Figure 19.

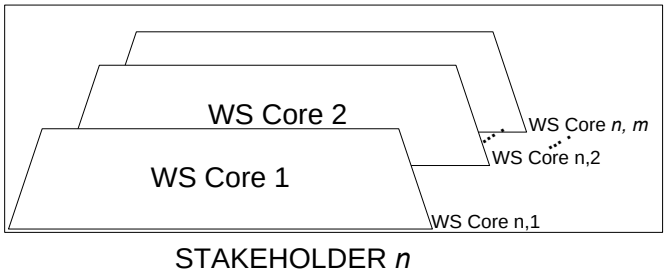

Figure 19 - Stakeholder Entity formed by multi WS Cores

Hence, in this scenario, Stakeholder "*n*" may have m WS Cores, servicing on a unique Result in a specific WS. Each WS Core may be in interaction with other WS

Cores of other Stakeholders. Different constellations of these WS Cores are the foundation of specific WS. Hence, Business Value Webs are actually WS formed by several collaborating related WS Cores of various Stakeholders. The WS Results given are harmonized in Figure 20. Any WS is formed by the contribution of the Stakeholders. Stakeholders collaborate on a business Results with their selected WS Cores. The contribution of each Stakeholder is shaped by the Context, Model and Concept of the business case. The WS Results are created by this collaboration in order to resolve an issue or satisfy a need elicited from the Environment [20], [23].

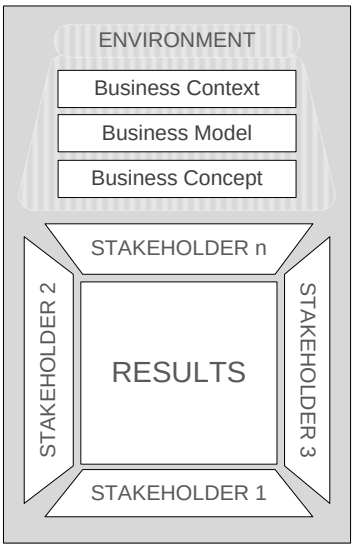

Figure 20 – WS, with Environment, Stakeholders and Results

4.4 WS CORE

The WS Core is defined as the place where the work is done [20]. In the HWSF, WS Core is tailored with respect to today's business context. WS Core is formed by 4 dimensions, which are Management, Organization, Information and Technology. These dimensions represent interdisciplinary perspectives; hence their harmonization is vital [40].

4.4.1 Management

Management is not only the execution of work necessary to produce the product, enable systems operation and exploitation. Moreover it is performing business development, creating Participants' and Stakeholders' satisfaction, achieving efficiency and effectiveness. All these require leadership skills and tacit knowledge in order to sense out the Business Context, elicit the opportunities, risks and concepts hidden in the Environment. In this sense, it is the most subtle element of the WS and forming the roof entity for the remaining entities in the WS Core as an interface to the outer world. In most of the guides, it is even mixed, missed or dominated by other concepts, or its important components may be positioned in way not so efficient and effective [20], [41].

In the HWSF, Management Dimension is defined clearly and positioned separately. Goals and Strategies of the corporation are discussed in Management Dimension. The inputs for them will come from the Environment externally. Management is positioned as a roof entity to aid other Dimensions' leveling. Management is performed in three levels; Senior, Middle and Low, as shown in Figure 21. In various literatures, they may also be referred as Executive / Corporate / Strategic, Business/ Middle and Operational / Transactional Levels respectively [19], [29].

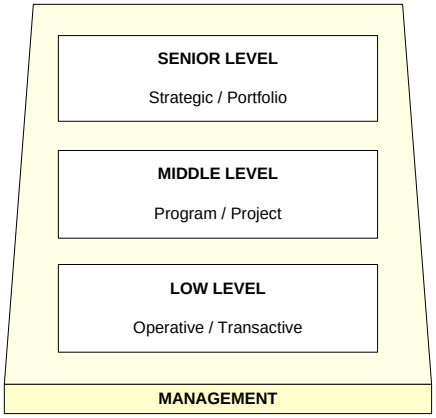

Figure 21 - WS Core – Management Dimension

4.4.1.1 Senior Management

This level of *Management* entity works on long term tasks with high importance, with Strategic and Portfolio Management Processes. Based on possible Business Contexts, Decisions on Corporation's Goals, Mission, Vision, and Governance are set here. Lower level Management efforts should be well aligned with them. This should be well stated and addressed to related Departments in Corporation Policies and Rules.

4.4.1.2 Middle Management

This level performs program, project, engineering and lifecycle management processes. They are vital for integrating the higher and lower levels of management, and may need agile and tactical actions.

4.4.1.3 Low Level Management

The lowest level Management works on daily operational and transactional issues, such as sales orders, budget and accounting flows, technical operations etc. Due to the conceptual and non-technical nature, Management Dimension is defined vaguely in literature.

4.4.2 Organization

Organization Dimension is more concrete with respect to Management Dimension. It is still highly conceptual when compared to Information and Technology Dimensions. One can easily sense the product or service given; whereas the *Organization* entities; Structure, Culture and Participants are mostly tacit or intangible. By the aid of work on both research and practice for Knowledge Management, there is a strong tendency to transform such knowledge into tangible and explicit forms [42], [43]. By this way, Corporations are expected to sustain and enhance their Structures and Cultures [44], and gain Business Intelligence [45].

This is one of the main reasons why organization and management are put in frameworks in different orders, totally depending on the perception of the author. In the HWSF, Organization is defined as an independent entity of WS Core. This entity is formed by Structure, Culture, and Participants Components as shown in Figure 22, [46], [47], [48].

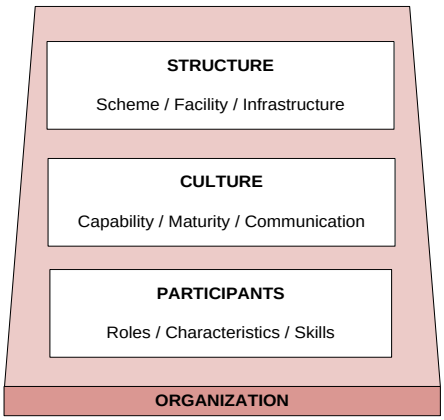

Figure 22 - WS Core – Organization Dimension

4.4.2.1 Structure

Most of the time, Organization Entity is just perceived as Structure, as it is the most concrete representation for the arrangement of Corporation entities like; function areas, management levels, and relative connections. Structures help to guide and see where a participant works and how communication can be done. They are also vital for positioning the roles and the function areas. Function areas may be instanced as departments in an enterprise or operation groups in a work systems. Their interrelations are defined by levels of Management Dimension and interrelating techniques like BP, Procedures, and Instructions.

Formerly, strict vertical hierarchical schemes for organizational structuring were very common with no alternative solution demands. Nowadays, due to the technological progress, process improvements and especially WS Approaches adoption, Organizational Schemes became more horizontal and distributed. They are even open to dynamical changes in accordance with the disruptive technologies,

agile methodologies and merging business concepts. Self-Organizing Systems is a trendy research to sample this change.

Facilities are the properties of Corporations, those are like buildings, plants, structures, for the performance of activities. They serve as the basis for the whole Corporation, not specifically serving particular WS Cores, Projects or other Endeavors. For this reason, in the HWSF, Facility entity is owned by the Structure Component within Organization Dimension. Accordingly, technical facilities are the common resources, like networks, structures or programming technologies. They all together form the Infrastructure of the Corporation [46], [47], [48].

4.4.2.2 Culture

The Structure of an Organization may be very similar to that of other corporations'. But, the Culture is unique for the Organization. Culture is one of the most sociological natured components of the HWSF, mostly analyzed in behavioral science field, and mostly skipped in Engineering and Systems research fields. It is based on shared ideas and behaviors which are mostly based on intangible knowledge developed over time. It represents the levels and means of Capability, Maturity and Communications of the Organization. Goals Alignment, Management Commitment and Participants Involvement strongly affected by this component. Organizational Culture is in high interaction with Business Environment, Context and other Stakeholders' Cultures [46], [47], [48].

4.4.2.3 Participants

Participants are the actors who perform the work with the aid of technology and information by the execution of BPs. Hence, they are the elements of WS with ultimate importance. They may have different roles for different tasks according to the Characteristics and Skills. With respect to all these criteria, Participants are positioned at different Management levels, in accordance with organizational structure and culture. In the HWSF, Participants are positioned in Organization Dimension. Participants may be both active in the creation of WS Results and just in receiving the WS Results in order to perform their other activities. In both cases, much attention should be paid for the impact of WS Participants, as they are the active entities for WS conduction. Hence, in addition to knowledge and career management issues in HR Management processes, alignment of Participants' to WS Core is strictly vital. In the HWSF, Participants will represent Human Participants only. The non-human Participants like web services, software agents, and automated machines are also mentioned under Participants Entity in WSF. In the HWSF, those non-human ones are defined in the Technology Dimension [46], [47], [48].

4.4.3 Technology

In all guides reviewed, Technology Dimension is explicitly shown and somehow defined in a common point. This is not the same for other dimensions or components. This situation shows the weighted Technical Perspective in general. This is evident

even in the guides aiming to have holistic interdisciplinary approaches. Still, Technology is not defined clearly in many of them, rather referred to the hardware and software used by the Participants in order to output WS Results. Some were clear about mentioning how it differs from Infrastructure [14], [20]. Technology is the total Tools and Materials specific to WS, used by Participants to create Results with the aid of Techniques as shown in Figure 23, [46], [47], [48].

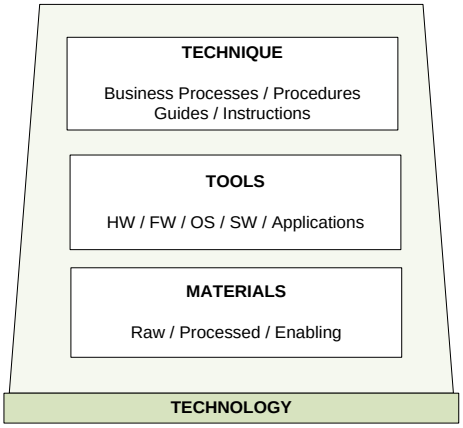

Figure 23 - WS Core – Technology Dimension

4.4.3.1 Technique

Work is done by executing the Work Flows, Operations, Activities, Tasks and other issues which may be ruled by Business Process Definitions, Procedures, Instructions or other items founding the knowledge base for the methodologies. Foundation methodologies given in guides, like best practices, models, standards, frameworks and constructs mentioned in IS Research Framework supports them with template offers. Today, BP is perceived as the systematic integration of items mentioned above. BP is a group of related activities and resources in order to output a value for corporation [12], [13], [50].

4.4.3.2 Tools

Techniques are implemented or run on the Tools. In the HWSF Tool definition, machines; like hardware or firmware platforms create the first level. Upon them, Operating Systems and Software Platforms are laid. Highest level entities of Tools are the Applications. With the aid of these Applications, Human Machine Interfaces are achieved, Code generation and execution is performed by the Participants. This situation of Tools is not only valid for IT sector, but also for any sector utilizing ICT based WS; like Engineering, Service and Finance [14], [19], [31], [32].

4.4.3.3 Materials

Materials used in creating WS results are also analyzed in Technology Dimension. These materials may be raw or processed materials, those can be extended to components, parts, assemblies and supplies consumed directly as an input or indirectly as an enabler in a BP to create the Result [14], [19], [31], [32].

4.4.4 Information

Information is the core of the business with WS today. But, it is not addressed directly in many guides. Information Dimension in the HWSF with its entities at different levels is shown in Figure 24.

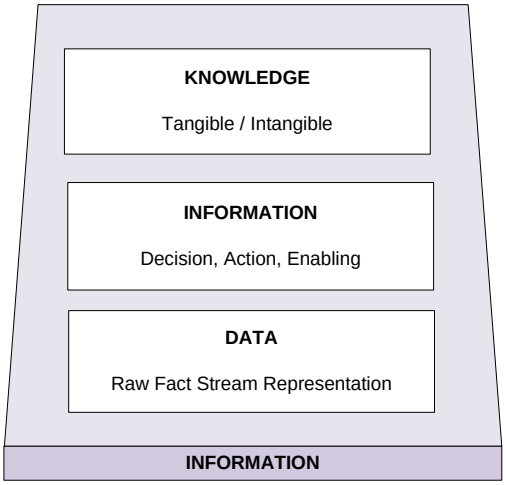

Figure 24 - WS Core – Information Dimension

Information is used in a BP with the aid of Technology to achieve a specific Result by the Participants. It may be an input, output, enabler or result. Information may be used either in-process, hence not visible to the Human Participants, or may be used with Human Computer Interactions. Due to the excessive usage of Information in WS and its increasing percentage within the Results, it is vital to dedicate an independent dimension on Information in the HWSF with detailed definitions. *Data* is the representation of raw facts. *Information* is the processed data with suitable arrangement and form. *Knowledge* is the ability of using Information, insights and ideas guiding decisions and deeds. It may be tangible, explicit or intangible, tacit [14], [20]. These Information entities are closely related with the levels defined in Management Dimension [19], [21]. For convenience, concepts like Intelligence, Understanding, Wisdom etc. are excluded from the HWSF, as they are more related with cognition rather than information.

4.5 WS CORE VIEW

Positioning these four Dimensions in WS Core requires interrelation of the Components. At this point, leveling helps a lot for this harmonization demand. The

policy and requirements on Participants, BP, Information, Technology and the cells in the Organization Structure change dramatically with respect to the Management Level they participate in. The related cells within the Structure, where these operations occur, also positioned in the Organization Scheme accordingly. The final WS Core is shown in Figure 25.

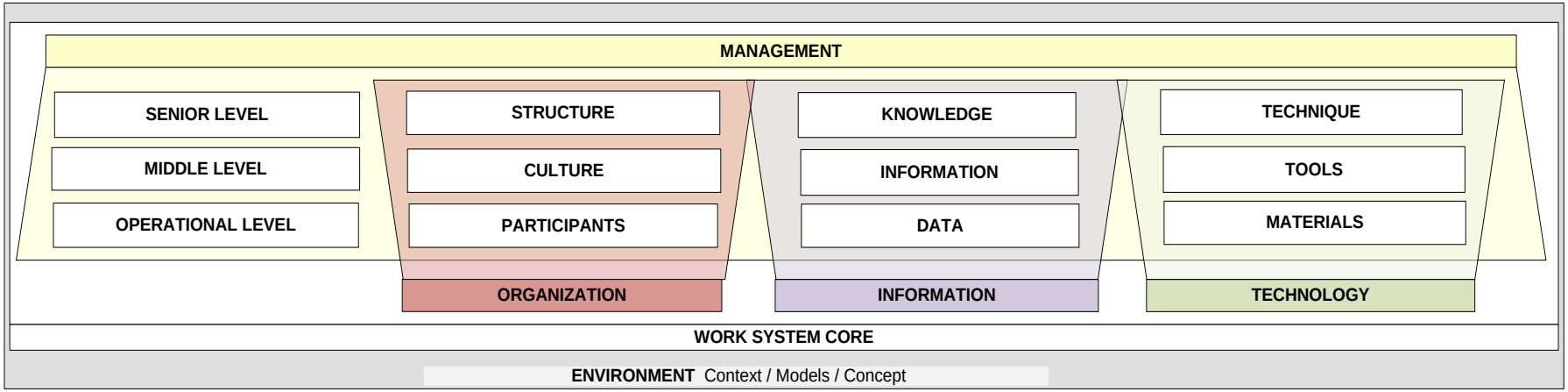

Figure 25 - WS Core of the HWSF

4.6 FINAL HWSF VIEW

In the HWSF, all Stakeholders, regardless their functions in the Business Value Web are presented around the WS Results. Results in the HWSF are the outputs of the interaction of the Stakeholders on the Business Concept, where all Stakeholders act with their specific WS Cores. Hence, the collaborated Results in the HWSF are more than being a product. They act as connectors between the Customers and the Producers as in WSF. Each Stakeholder works with its own WS Cores. The collaboration is aided by the seamless workflows of the Information and Materials via different BPs of WS Cores. For the sake of simplicity, the detail of WS Core given in Figure 25 is eliminated in final the HWSF view as shown in Figure 26.

In this depiction, there are "***n***" Stakeholders forming a constellation with their various WS Cores around a Result within the Environment. With this manner, only one WS Core of each Stakeholder is shown with the labels "***x, y, z*** and ***w***". but their multiple alternatives are referenced with the letter "***m***". The collaboration on the Results and multilateral interactions between each Stakeholder is represented by double headed arrows. In addition to dimensioning; the ambiguity of the floating components around the WS Core in WSF, like Environment, Infrastructure and Strategy are cleared. In the HWSF, they are embedded in the related entities.

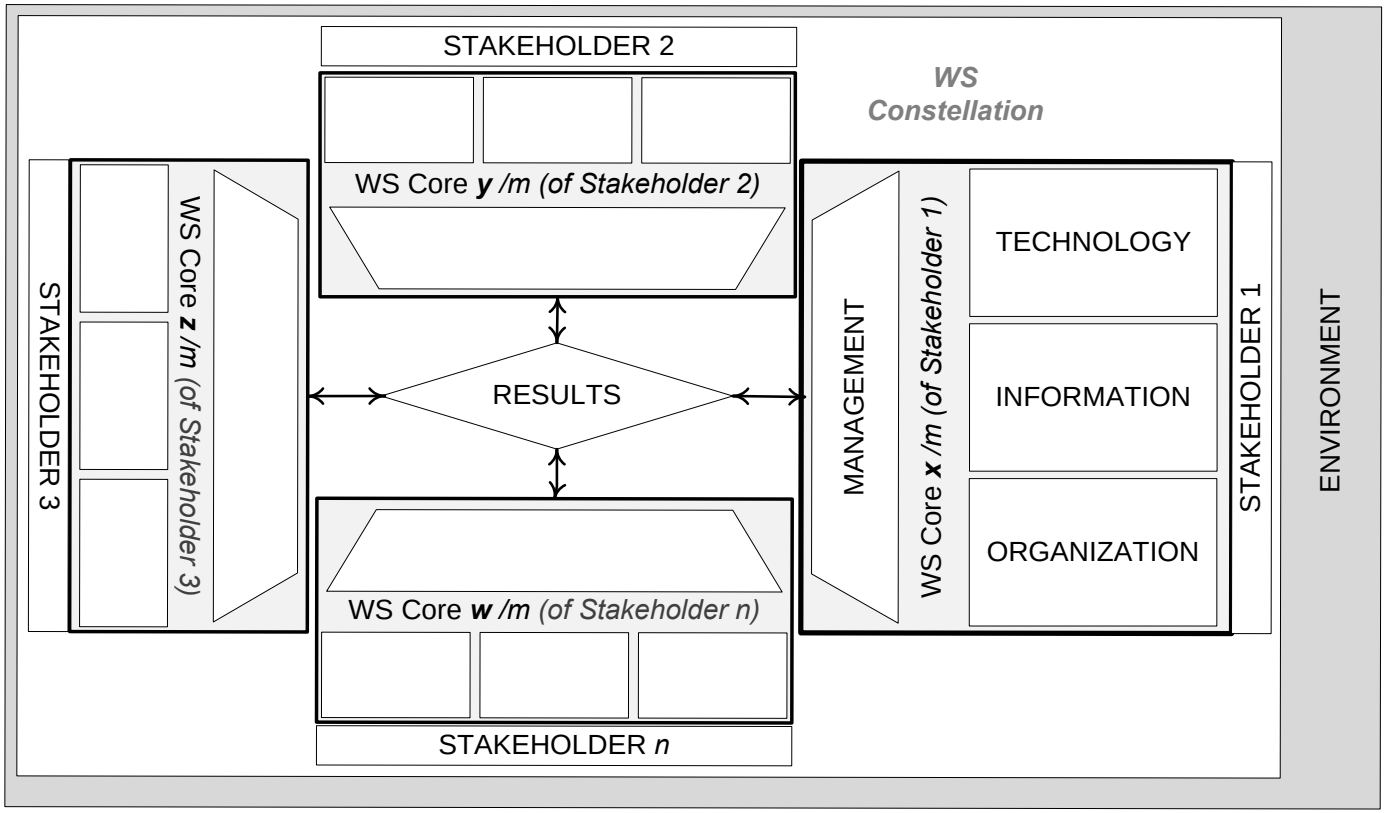

Figure 26 - The HWSF

CHAPTER 5

THE HWSF EVALUATION

In the evaluation process of this work, IS Research Design Science Guideline is used [14]. It harmonizes behavioral science and design science paradigms in order to characterize Systems Research discipline. In accordance with this guideline, the verification methods used in the HWSF Evaluation is presented in detail in this Chapter (Guideline 3). These methods are classified in four main groups of Descriptive Evaluation, Analytical Evaluation, Observational Evaluation and Experimental Evaluation.

5.1 DESCRIPTIVE EVALUATIONS

The HWSF has the form of framework, and the nature of frameworks is highly conceptual. The HWSF Design Process is based on the analysis of the descriptions within the Knowledge Base founded which is presented in detail in Chapter 4 [20]. According to IS Research Desing Science Guidelines, Descriptive Evaluation is compulsory for the artifacts in conceptual forms [40]. For this reason, Descriptive Evaluation is utilized intrinsically as an initial step for the HWSF Evaluation, with Informed Argumentations, Comparison of the existing guides and Scenarios for the artifact's utilization.

5.1.1 Informed Argumentation

In the HWSF Research Design process, a Knowledge Base is founded from the academy and industry literature of WS Domain. The Knowledge Base includes 1) WS foundations, like theories, frameworks, models and instantiations; and 2) Case Studies, Field Studies and their combinations. These former studies ascertains the lack of holistic approach supported by interdisciplinary perspectives and systems thinking in WS efforts and the demand of suitable guidance [34], [40], [50], [65], [90], [91]. The foundations of the Knowledge Base is well exploited and reffered throughout this document as the source of Informed Argumentations those enabled concrete definitions of situational analysis, literature research, ws guidance study, domain requirements elicitation, gap analysis, design and evaluation processes, WS Concepts and the HWSF entities, which are well detailed in Chapters 0, 0, and 0.

5.1.2 Comparative Analysis of the Existing Guides

The Evaluation of the HWSF continues with the comparative analysis of the selected guides from the Knowledge Base. The selection is ecxecuted according to the HWSF Goal defined in Chapter 1.4. This comparaison is extremely useful for analysing the WS Entities, Dimensions, Levels, Strong and Weak Sides as shown in Table 2. As shown in the table, each guide uses different interdisciplinary approaches. All guides are strong in interdisciplinary characteristics but weak in their balance, hence lacking a healthy Systems Approach.

Table 2 – Comparative Analysis of the Existing Guides

FW	***Goal***	***Strong Sides***	***Weak Sides***
10	***Interdisciplinary Approach***	Technical, Behavioral	Better harmonization is strongly reccommended
	Systems Approach	Socio-Technical	Complementary FWs Support
	Conceptualization	High	Not in unique view
	Components	Plenty	Re-allocation demand
	Dimensions	Perspectives	Lack of Information Dimension
	Levels	Exist in some views.	Harmonization demand
WSF	***Interdisciplinary Approach***	Technical & Social	Better harmonization is strongly reccommended
	Systems Approach	Work Systems	-
	Conceptualization	High	-
	Components	Plenty	Re-allocation demand
	Dimensions	-	Dimensioning demand
	Levels	-	Leveling demand
Mobile Business FW	***Interdisciplinary Approach***	Technical, Financial	Better harmonization is strongly reccommended
	Systems Approach	Mobile Systems App.	Support of other views
	Conceptualization	Exists in Low Level	Not in unique view
	Components	Plenty Components	High Complexity
	Dimensions	Views	Low Usability
	Levels	Exists in some views.	Harmonization demand
IS Research FW	***Interdisciplinary Approach***	Engineering, Behavioral	Better harmonization is strongly reccommended
	Systems Approach	Systems Thinking	Balance demand
	Conceptualization	Medium	Improvement is strongly recommended
	Components	Plenty	Re-allocation demand
	Dimensions	-	Not articulated clearly
	Levels	Slightly depicted	Improvement demand

Systems approaches are elaborated in Socio-technical Systems Thinking, WS Thinking, or Systems Thinking and applications. However, it is difficult to find Systems Approach in a single view, which in turn necessitates the aid of other complementary views or frameworks. This situation increases the complexity, decreases the usability, and hence lacks the holistic approach. Conceptualization of the components in the existing guides is found to be satisfactory, but the dimension and level definitions are not articulated clearly in the existing guides. This is an indication for the lack of components' harmonization. In order to achieve this harmonization, the reallocation of the components with respect to well defined dimensions and levels is required. The results gained by this comparative analysis strongly aided the harmonized design in order the reach the HWSF goal. Naturally, these evaluation metodhs take part concurrently with the design in the whole HWSF lifecycle [14], [40].

5.1.3 Scenarios

In this evaluation method, simple and short scenarios are defined, in order to show how the HWSF redress the current situation for eliminating failures in WS stories. There are two scenarios created by the compilation of the descriptions given in the design and evaluation of the HWSF. The first one is more abstract, where the details of WS conduction are given in the second one.

5.1.3.1 The HWSF Guidance for WS Building

Let Stakeholder "n" have "m" WS Cores, namely WS1, WS2, and finally WSm. Each WS Core serves for a specific WS for a unique WS Result. One WS Core may be utilized for Inventory Management, the other for Portfolio Management and another for Engineering Management. These functions may be executed with the common aid of various Enterprise Platforms and Applications, such as Transaction Processing Systems, Decision Support Systems, and Excecutive Support Systems etc. Each WS Core owing these Technology entities (Tools and Materials) may be operated by internal corporation Participants with specific internal BPs, with respect to corporation Structure, Culture and Management practices.

For creating a result, one of these WS Cores may be in interaction with another WS Core owned by either the same or other Stakeholders. In order to build a such WS Core interactions actually build System of WS Cores. This SoWC is a temporary endeavor or Business Value Webs. They may be in the form of a Project, Business Model, Partnership or Business Alliance.

Today, formation of different WS in the Business Environment with respect to the Business Context is eased by the convergence and integration of the progressing disruptive technologies. In order to build such a WS in the Business Environment with respect to the specific Business Contexts today, Executives must pay attention not only the Technology, but also to other criteria embedded in the HWSF Entities [19], [20], [29].

For example the allocation of the Actors, especially for the ones acting as point of contact, is critical. The skills, expertise and knowledge of the Participants who will act these roles are also highly critical, because the criteria for these are now actual

not only for internal to the corporation, but also for across the whole Endeavor. Collaboration of two Stakeholders with totally diverse Structure and Culture with different Management practices can be eased with the HWSF Guidance, by each Stakeholders' clear definitions on their features and what they are expecting from relevant parties. Otherwise, skipping these important points are frequently observed in any market. Still, Technology in WS should be well harmonized. This can only be done enabling the interoperability of the platforms and tools, and with the orchestration of the BPs for work conduction and information flow. The level, format and timing of the Information that will flow throughout the WS should be well defined and planned in advance. Many times, extra information with detailed structured data is presented to Senior Level Management, who do not have time and attention to create Knowledge or Wisdom from such information.

5.1.3.2 The HWSF Guidance for WS Operation

A more detailed scenario for WS conduction can be constructed as follows. Participants at senior management level perform executive BPs which serve for the activities of strategic or portfolio management areas or similar. Based on possible business contexts, corporation's goals, mission, vision, and governance should be set here. Information level serving these unstructured decisions is highly refined and mostly serves for knowledge management issues. For this reason, complex application platforms, like executive support systems, with advanced graphics and communication tools are used. Information is highly refined and mostly serves for knowledge management issues. Regardless the organizational structure and culture, either strictly vertical hierarchical or distributed, lower level management efforts should be well aligned with them. This should be well stated and addressed to related units with the aid of BPs and supporting organizational regulations at various levels. This is the way to organizational learning and knowledge management [19], [20], [30].

At middle management level, participants execute tactical BPs serving activities of like program, project, and engineering or lifecycle management areas. They are vital for integrating the senior (executive / strategic) and base levels of management. Here mostly semi-structured decisions are set, and they may need agile and tactical actions. Platforms like decision support systems or management information systems with data and information analysis orientation are utilized.

Lowest management level participants perform daily operational BPs serving areas like production, accounting, budget or order management areas. They perform highly structured decisions makings. The tools do not have to be highly advanced like the former ones. In generic, they use transaction processing system applications. Information input is streams of data and output is low level of information mostly. BP are very explicitly defined, mostly in Operational Instructions formats. Knowledge is much more tangible.

5.2 ANALYTICAL EVALUATIONS

The results of the descriptive evaluations given in Chapter 5.1, strongly support the Analytical Evaluations accomplished, which are composed of Static Analysis, Optimization, Architecture Analysis and Comparative Analysis.

5.2.1 Static Analysis

In *Static Analysis*, the HWSF's structure is examined with respect to the static qualities of (1) content spectrum and (2) complexity [14].

The content spectrum is enormously increased in the HWSF with respect to those of the related work rviewed. This is achieved by paying the highest importance to the socio-technical approach given in the WS definition. In this way, an interdisciplinary approach, depicting both technical and non-technical disciplines, includes engineering, applied, social and administrative Sciences are enabled as the HWSF entities. In addition, behavioral, information, and financial sciences are also utilized in the HWSF. The HWSF Entities are instanced from all these mentioned disciplines. This situation brought a wide range of *content spectrum* enabling interdisciplinary approach in the HWSF. Related former work lacks interdisciplinary approaches, hence many of their instances are also deficient [14], [19], [20], [53].

In the HWSF, all these necessary entities are presented with high level of conceptualization. This is achieved by the visual depiction of the entities and their brief textual definitions. Moreover, the architecture of the HWSF is given from a unified view. These enabled holistic approach of minimum *complexity* for high usability [14], [20], [36], [40].

Hence, both static quality factors are achieved in one pure unadorned structure with necessary contents. This is an immense achievement when compared with the former guides as given in Chapter 5.1.1. The results of the content and complexity analysis become more visible when handled togeteher with the comparative analysis given in Chapters 5.1.2 and 5.2.4.

5.2.2 Optimization

*Optimization*s [14], are instanced in several ways in the HWSF. Harmonization of the WS entities is achieved by defining their relations. This brought the holistic approach to the HWSF. Both approaches enable the socio-technical WS thinking in the HWSF. With the aid of the findings from the literature study, comparative, descriptive and static analyses; Dimensions and Levels are clearly composed to redress their merging, skipping or disambiguation. Entities are classified, renamed when necessary and allocated accordingly in a correct manner within the related dimensions and levels [29], [92]. By these optimizations, the 3 staged Leveling both in Core and Environment ease users' analysis of a WS.

5.2.3 Architecture Analysis

The HWSF's compatibility with technical systemsresearch and practice is verified using *Architecture Analysis* accomplished by an experts group. This group is formed by the senior researchers and practitioners working on the WS; who mostly work at private and academic sectors; engineering and consultancy fields; possess high level management positions or owing post-graduate degrees. Thus, a high level of expertise characterizes the group, which serves in field and case studies also.

During the *Architecture Analysis*, the HWSF's Dimensions, Levels and all Entities are clearly composed to redress any underestimation, disambiguation or imbalance inhibition for a full WS representation. The structure of the WS Core is suitable to represent various WS Cores of a Stakeholder and their interrelations with other WS Cores either internal or external to the owing Stakeholder as in the created scenarios during Descriptive Evaluation in Chapter 5.1. This architecture is also found to be completely conformal for the modeling or simulation of systems, enterprise or BP architectures with any standards like Architecture Analysis and Design Languages or Business Process Model or Notation. In this regards, the *Architecture Analysis* easily asses the HWSF fit for any WS Concept utilized in any sector like research, education, production or service [14], [40].

5.2.4 Comparative Analysis of the HWSF

In this evaluation method, comparative analysis of the HWSF with respect to the HWSF Goal defined in Chapter 1.4 is given. It is strongly recommended to review the selected guides' comparison given in Chapter 5.1.2 in advance, in order to well understand how the HWSF redresses the current situation for eliminating failures in WS stories.

In most of the existing guides, *Environment* is defined as where the business is done in a very abstract way [19]. In the latest versions, WSF began to show *Environment* as an explicit entity external to the WS [93]. Some defines Environment as the ambient where problem domain and object of interest reside [94]. Similarly, *Context*, *Model* and *Concept* for business are also not clearly mentioned enough. Clear depiction and definition of these HWSF Entities enable *Participants* to analyze *Environment* as a business opportunity source, create the *Goal* for their WS.

Products are the central entity for any WS. They are the Results of WS and the reason why WS are constituted for as a Business Goal. In most of the existing guides, they converge to physical products and a result of the producer. This convergence is even implicit in many of the guides. In the HWSF, the changing form of the *Products* and the collaborative multi-Stakeholder configuration on them are clearly shown. For this reason, products are defined as *Results*.

This depiction is believed to aid users to analyze the WS Results in accordance with Business Context and Model in relation to other Stakeholders. Here, even Customers are also taken into account as a *Stakeholder*. This increases the attention on them by increasing their value from non-collaborating End-users. In the HWSF,

Stakeholders are also defined as a configuration of specific WS Cores. For instance, Stakeholder *n* has *m WS Cores* (namely WS_1, WS_2, … WS_m) serving in a specific WS for a unique WS Result in collaboration with other Stakeholders' WS Cores.

In most guides, *Management Dimension* is not defined explicitly. In WSF, there are implicit references of *Management* within *Business Process*, *Participants* and *Strategy* components. In addition, fuzziness on *Strategy* definition is seen, although it is explicitly shown. It is perceived as an external entity to WS, but a clear relation between *Environment* and *Strategy* is also lacking. In IS Perspective Framework, *Strategy* is defined and analyzed under Management Dimension as a function of Senior Level Management. IS Research Framework's view on Strategy is somehow relevant with this view, but misallocated under Organization Dimension. In the HWSF, *Management Dimensions* and tied components are clearly shown with improved definitions, with the aid of non-technical disciplines' definitions. With the HWSF usage, users may clearly see that *Goal* and *Strategy* are internal to WS and they are *Senior Level Management* activities. They are achieved by Management's Commitment and Participants' Involvement. *Goal* is the final destination of the WS, elicited from the business opportunities and needs embedded within the *Environment*. *Strategy* is the entity aiding to align WS Core Entities to the Business Goal set for the WS [14], [19], [20], [29], [94].

Similar to Management, *Organization* is not mentioned by WSF also. But WSF stressed on components tied to Organization, such as Participants and Business Processes in WS Core. Some research saw this flaw and tried to mention Organization within Participants and offered a slightly revised version of WSF [91]. Both IS Perspectives and IS Research FW defined and showed Organization well with different components allocation. This perception and definition difference arouses because of the conceptual level of this dimension. In the HWSF, users may analyze the WS Structure easily, positions and relations the roles and responsibilities of the *Participants*, their contribution to the embodying the WS Culture with the aid of Facilities, Infrastructure, Knowledge and other resources.

BP Component is also taken very differently in the existing guides. IS Perspectives mentions BP in Management Dimension. WSF takes it central to the WS and uses it as the interface between WS Core and the Product. IS Research FW defines it within Organization. During using the HWSF, the user will see that the interface of WS Core with Stakeholders for collaboration is not only composed by tangible BPs (like in WSF case), but also intangible assets, like Strategies, Structure, Culture and Participants. Besides, the user will become clear that BP in various forms and levels are to define the methodology for the WS conduction, and Methodology is a subject of Technology actually. Hence for WS Conduction, users would be clear to analyze their issues with respect to not only the technical tools, but also accompanying materials and BPs. This dramatic revision with respect to other FWs is in accordance with Organization Studies and BP odyssey converging to Systems Thinking [12], [13], [35], [36], [37].

From this point, it becomes clear why it is important to define Information Dimension separately with suitable the levels with respect to their policy, requirements, appliance and rights. The HWSF user will analyze the WS Conduction according to different Information levels, in relation to Management Levels, Organizational Features, BPs, Tools and materials. For simplicity and coherence, higher level definitions for Information like Understanding or Wisdom are excluded from the HWSF work.

The HWSF's clear depiction Dimensions and Levels absolutely helps for identifying all interdisciplinary WS Concepts with suitable HWSF Entities in a unique view, with high level of conceptualization and relations. At this point, it is it is important to summarize the comparison the HWSF with respect to the design criteria given in Chapter 1.4. The summary comparison given in Table 3 will enable accordance between this chapter and Chapters 5.1, 5.2.1, 5.2.2, and 5.2.3. When Table 3 is analyzed together with Table 2 given in Chapter 5.1.2, it can be found out that the HWSF easily asses the design goals and bridges the chasm mentioned in Chapter 1.3.

Table 3 - Comparative Analysis of the HWSF

Design Criteria	***Optimization***
Interdisciplinary Approach	Technical, Social, Information, Managerial
Systems Approach	WST
Holistic Approach	Unified
Instances	***Optimization***
Entities	Plenty of necessary entities
Dimensions	4 Dimensions in the WS Core
Levels	3 Levels in WS Core and Environment

5.3 FIELD STUDIES

In order to enhance the HWSF Evaluation, observational evaluation methods are utilized upon to descriptive and analytical evaluation. For Observational Evaluation, Field and Case Studies are performed. With these studies, Observational Evaluations form the bridge between theoric evaluations (Descriptive and Analytical Methods) and pratic evaluations (Experimental Methods). In this Chapter, the Field Studies performed by Surveys and Interviews is shown in detail with their results and analysis. Case Studies, as the next round of Observational Evaluation is given in Chapter 5.4.

5.3.1 Surveys

Surveys are performed with 60 participants. At the beginning of the surveys, participants are not informed about WS Concept, WST or WS guides, in order not to influence their answers and to assure objectivity. During the surveys, they are objectively required to define their work concept, their perceptions on the system how they perform their work, what they utilize during their work execution, and how they interact with other entities in their work. The number of answers is transposed to 50 in the average by excluding the extreme ones which are out of coherence band.

Participants are the experts selected from the corporations with a common set of features including high utilization of information and service based WS; exhausting practices of Engineering and Technology Management activities; and following-up the guides in various forms, especially standards, models and frameworks. They are working at public, private and academic sectors as well as in engineering, support and consultancy fields at various management level positions, possesing various levels of graduation degrees. The sample space is weighted by field (engineering) and sector (public and foundation).

The sample space possess a wide range of experience (years worked) and positions (management level), which helped ensure objectivity [95], [96]. The range of experience range of the Participants is very wide with the majority in 10 to 20 years range. New beginners (<5 years) and seniors (>30 years) have also participated in the study. Their details are shown in Figure 27 to Figure 31.

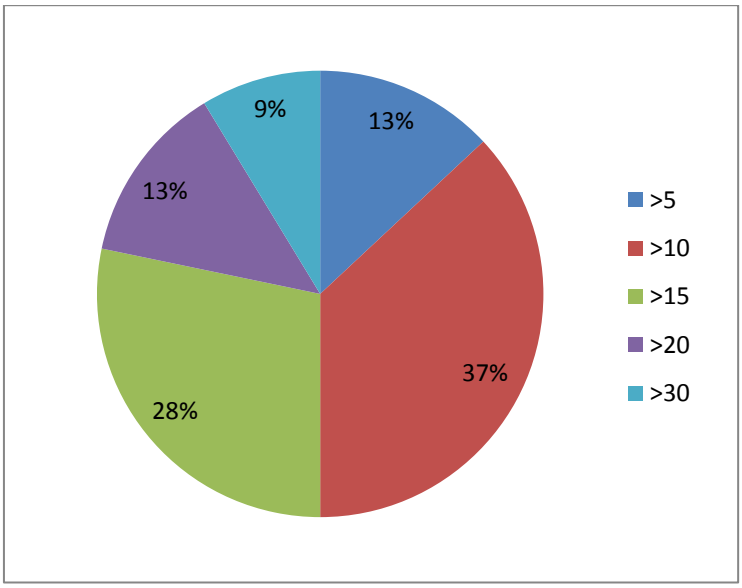

Figure 27 – Participants' Years of Experience

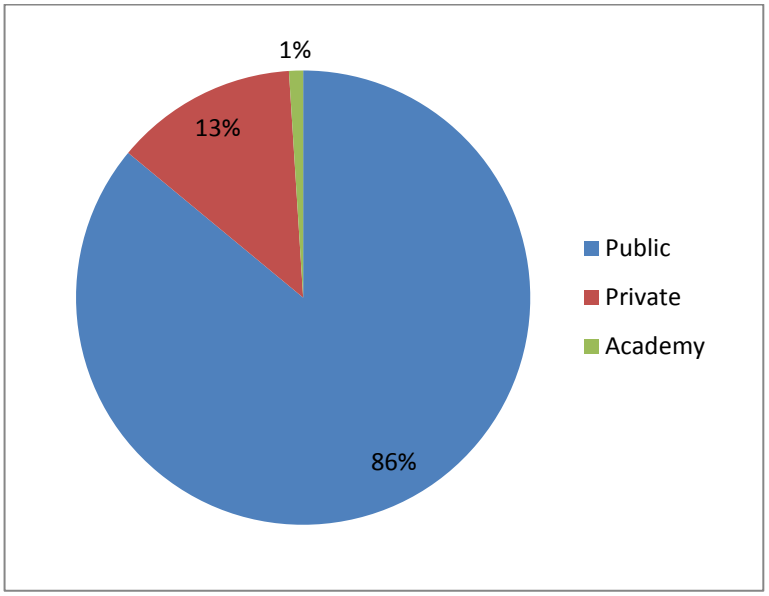

Figure 28 - Participants' Sectors

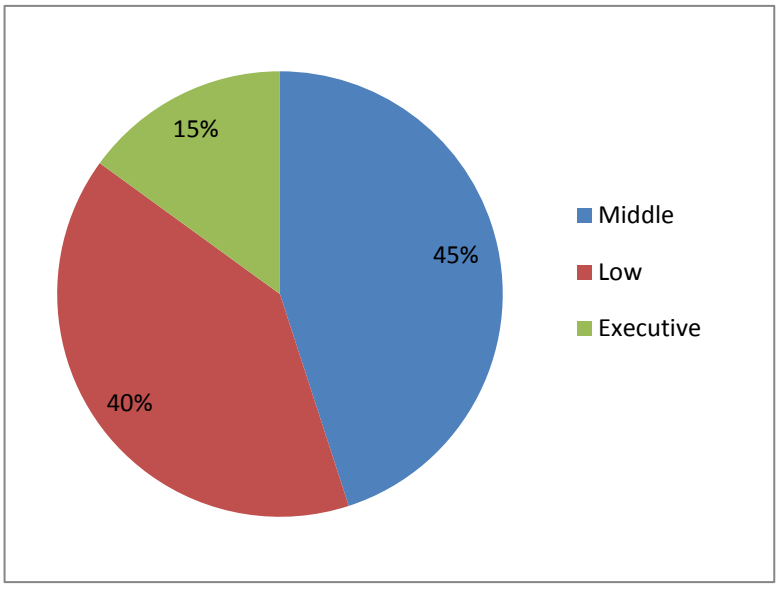

Figure 29 - Participants' Position in the Corporation

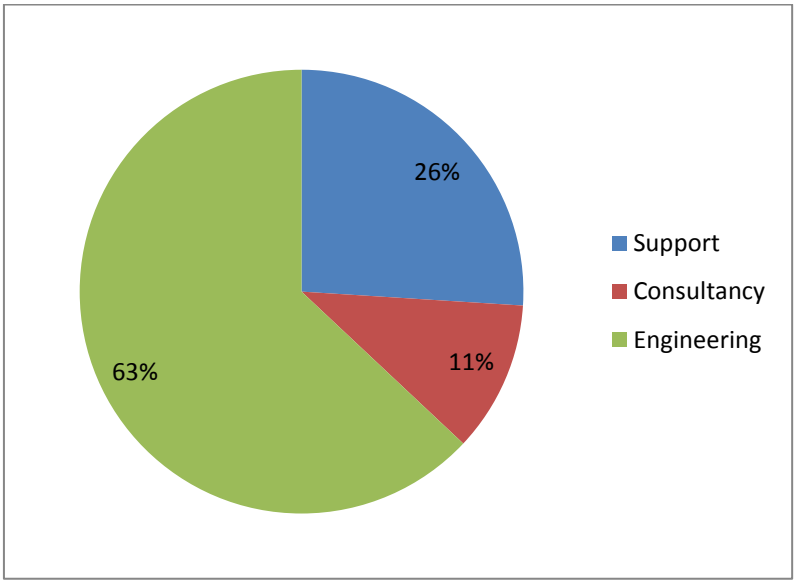

Figure 30 - Participant's Field

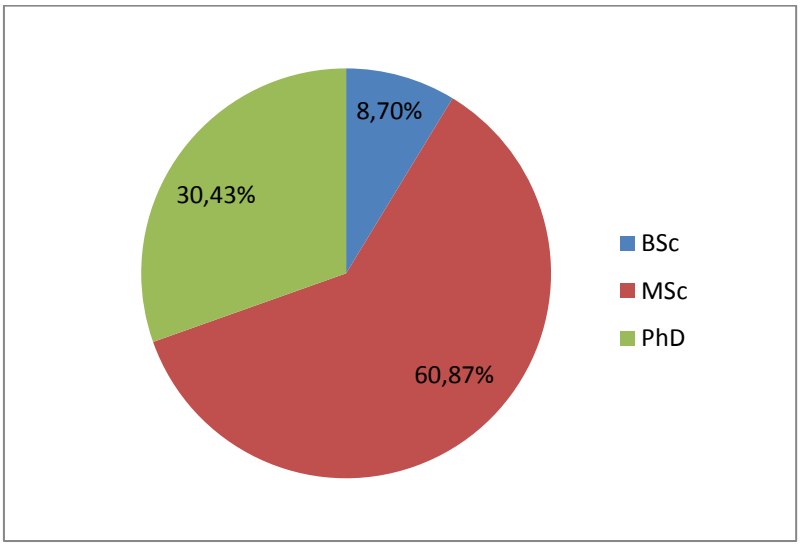

Figure 31 - Graduation Degrees Percentage

Participants mostly mentioned Systems Engineering (~90%, including application engineering), Project Management (~70%), Configuration and Quality Management (both ~50%) followed by Risk and Requirements Management and Software Engineering, as business activity areas relating to their work, as shown in Figure 32.

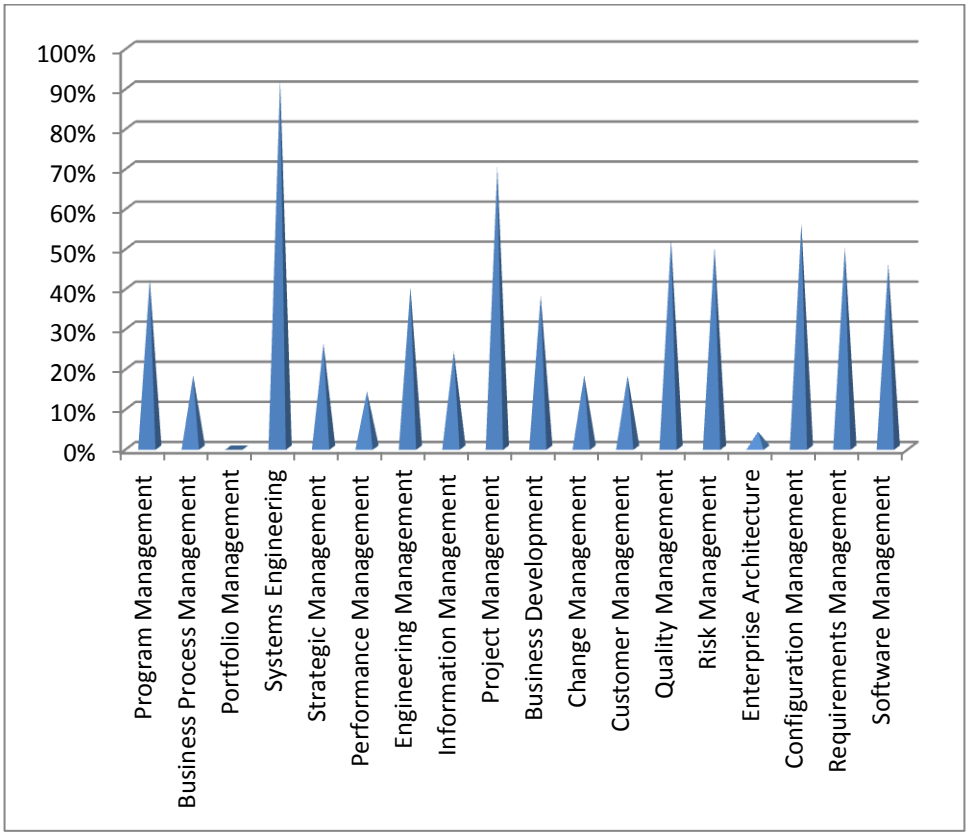

Figure 32 - Corporations' Percepted Activities

Survey participants; expect activities on Program (>30%), Process (>15%), Portfolio (<15%), Strategic (<15%) and Performance Management (<15%) to be held in their WS within 5 years, as shown in Figure 33. Participants are asked about the guides they follow during their activities. Awareness on the ISO 9001 Standard was prominently mentioned (85%). It was followed by CMMI (76%) as in Figure 34. Additionally, they were asked for the corporation's certifications and future plans for these guides' utilization. The results are given in Figure 35 and Figure 36. At this step, the awareness on ISO 9001 decreased interestingly. Especially, in future plan case, ISO 15288 came to the scene as a guide to be followed for for future plan.

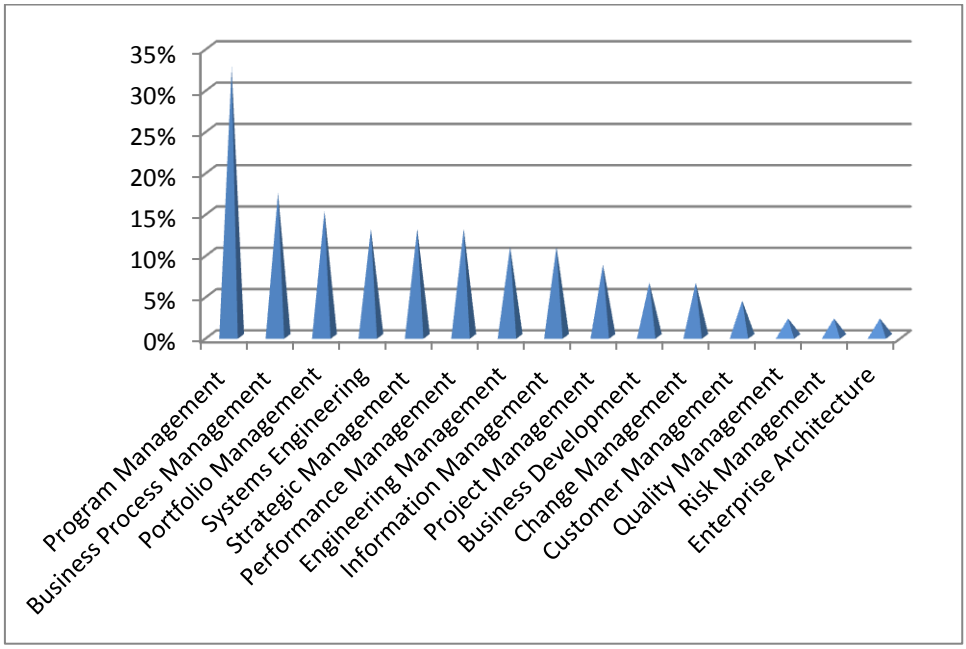

Figure 33 - Corporations Expected Activities

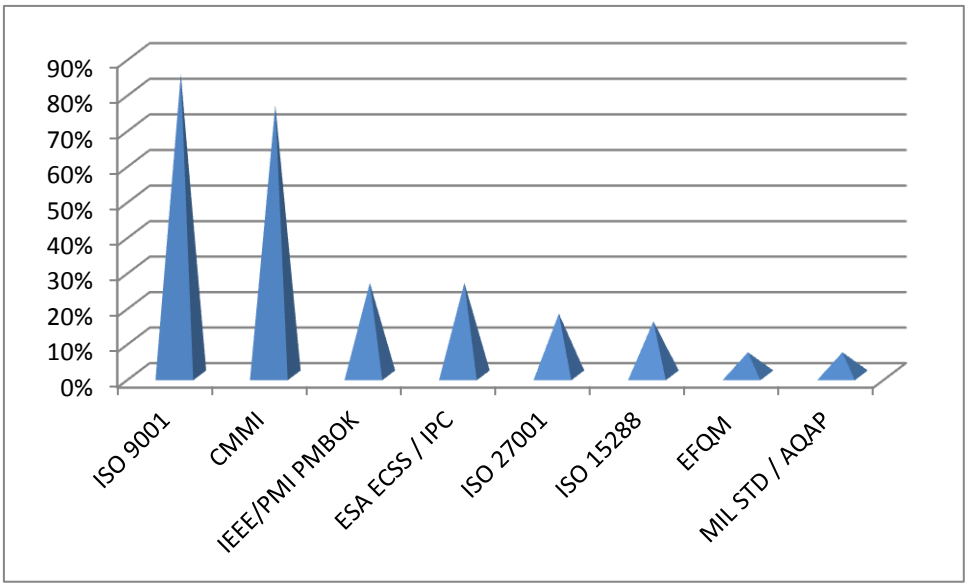

Figure 34 - Guides Followed by the Participants

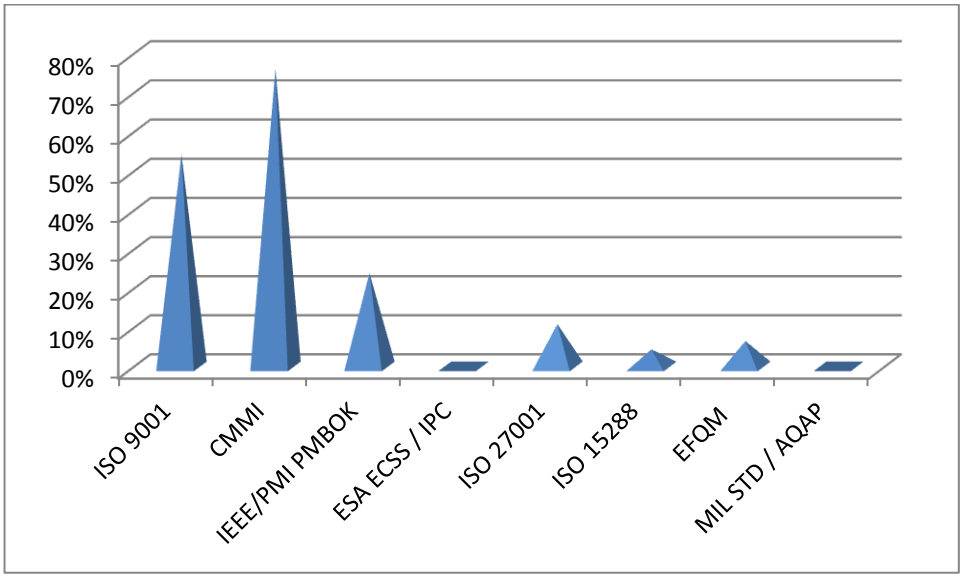

Figure 35 – Corporations Guide Certification

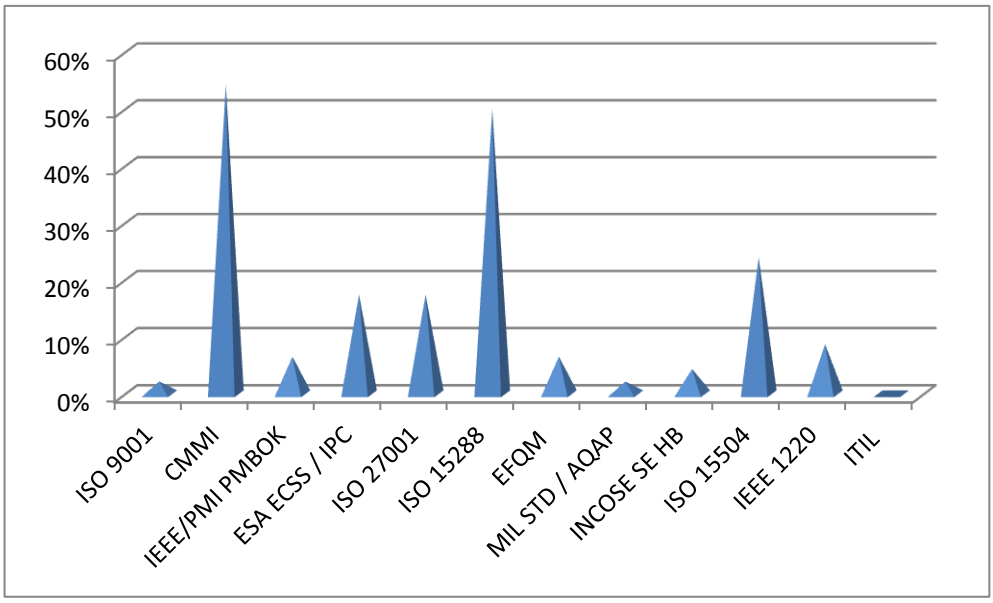

Figure 36 - Guides planned to be followed by Participants

Upon to this step, Participants are asked to score their guides and activities in the range of [1, 5], where 1 indicates lowest level, 2 moderately low, 3 moderate, 4 moderately high and 5 indicates highest level. In this case it is important to mention that the moderate level of 3 also indicates the mid value of this range, as there is no zero value. The average value of the Participants' is calculated as a real number to analyze the survey results in order to compare it with the integer levels given in the range of [1,5]. For this comparison, the median value of the answers is not as healthy

as the average value, as the median value directly converges to one score level in between 1 to 5. Still, the median and the cumulative increase of the answers are shown to aid readers in Figure 37 to Figure 53.

Participants responded the usability of the guides utilized as 2.86/5.00 in the average (below moderate), as in Figure 37. According to the Participants, timeliness of the activity definitions in these guides are below moderate; and scored as 2.60/5.00 on the average, as in Figure 38. Similarly, the coverage of these definitions within their business activities was weighted as 2.80/5.00 on the average, as in Figure 39.

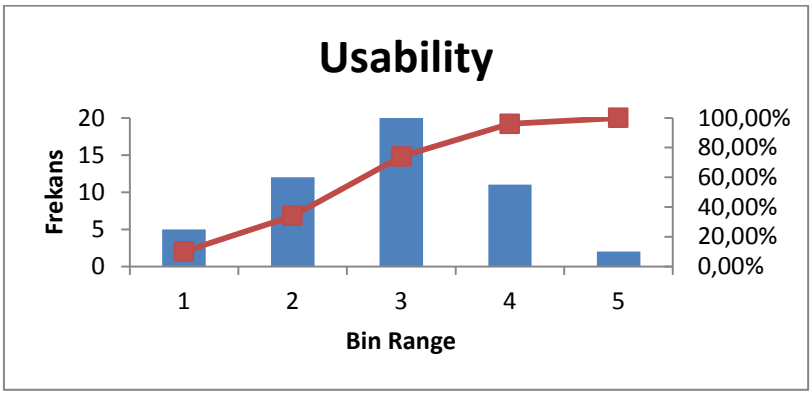

Figure 37 – Usability of the Guides followed

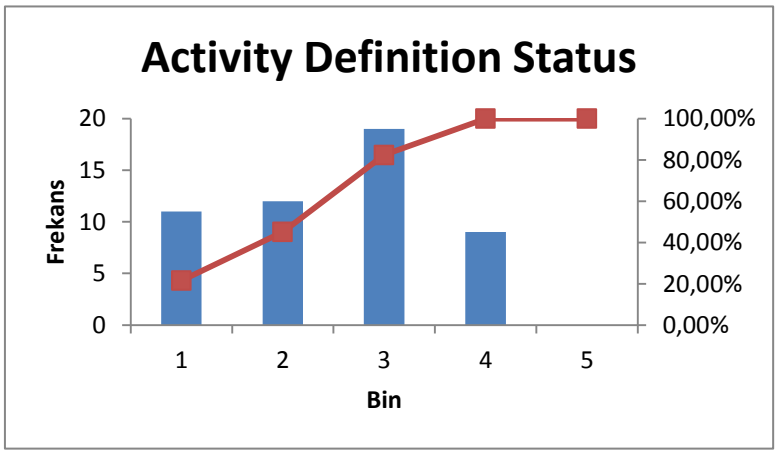

Figure 38 - Definition Status in the Guides followed

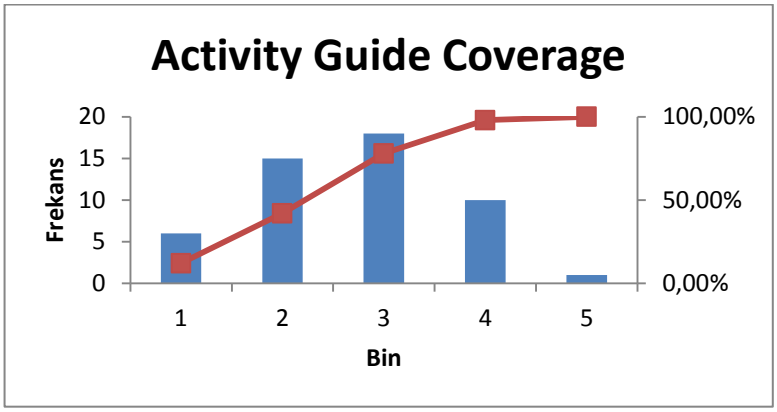

Figure 39 - Corporation Activity - Guides Definition Coverage

The correlation of their business activities with the guides is resulted as 2.90/5.00 on the average, as shown in Figure 40. Participants assessed their corporation's business goal definition clarity as 3.10/5.00 as shown in Figure 41.

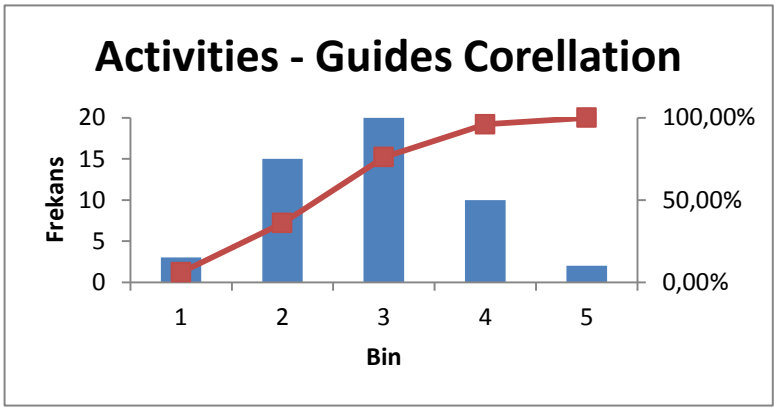

Figure 40 - Corporation Activity – Guides Definition Correlation

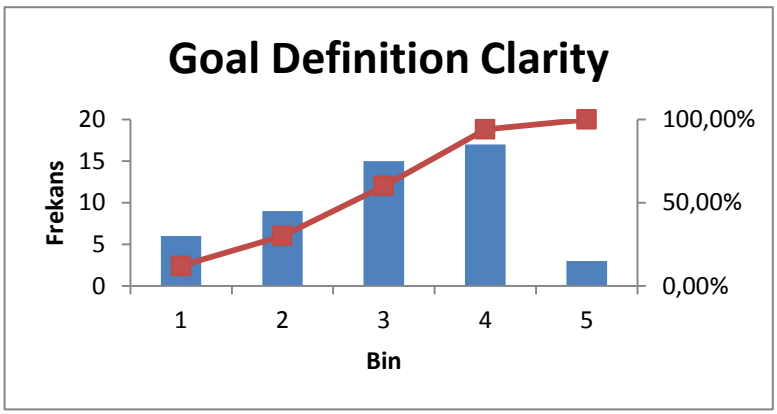

Figure 41 - The clarity of the definition of the Business Goal

The correlation of business goal with corporation's business activities were perceived as 3.10/5.00 by the participants. This average value is slightly above moderate, as shown in Figure 42. The correlation of business activities between each other were 2.80/5.00 as shown in Figure 43. This value is below moderate and the average of Figure 42. For implementation and improvement of their WS activities, the Participants responded for the Benefit to Cost Ratio as 3.04/5.00, as shown in Figure 44. For the main motivation of WS decisions, Participants answered Management Initiative (59%), rather than Organizational Demands, Market Trends or Customer Requests, as shown in Figure 45.

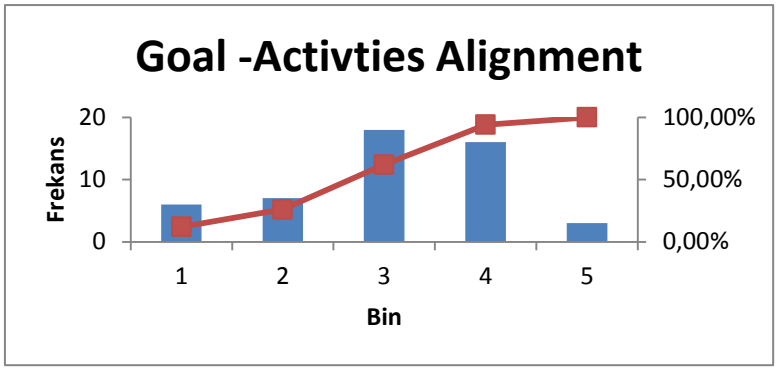

Figure 42 - Corporation Activities' alignment to the Business Goal

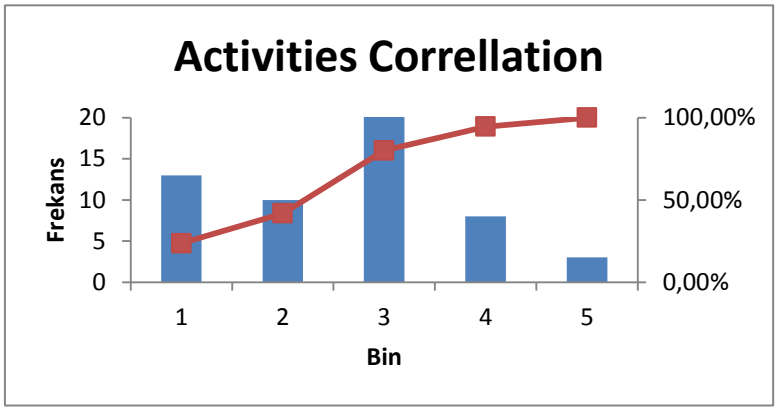

Figure 43 - The Correlation of the Corporation Activities

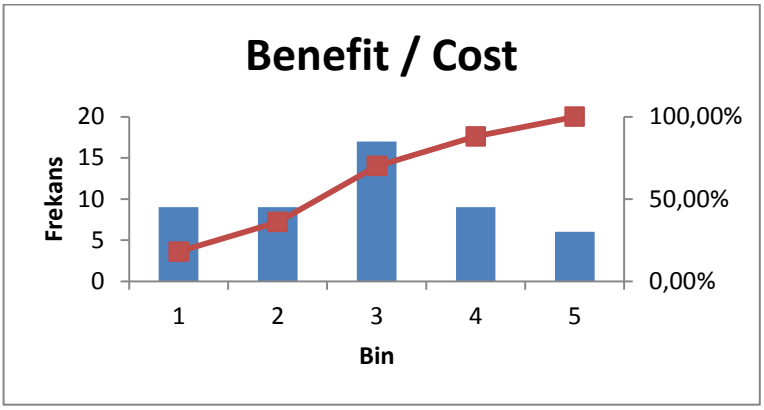

Figure 44 - WS Implementation Improvement Benefit Cost Ratio

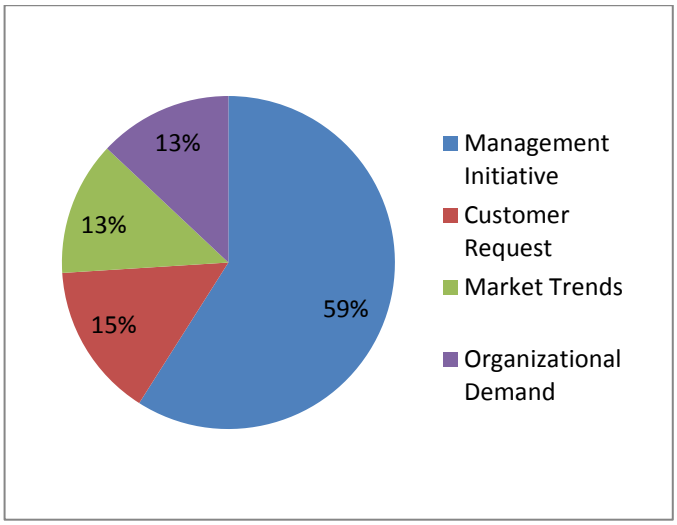

Figure 45 - Perceptions on WS Motivation

Participants assessed Management's Commitment as 3.28/5.00, as shown in Figure 46; and Stakeholder Collaboration as 2.54/5.00 as given in Figure 47. Participants' Involvement was asssesed as 2.74/5.00 during these WS Improvement Activities, as given in Figure 48. Based on these steps, Participants were expected to define their Work Systems. For this reason they are first asked about their main approaches to their WS. Technical Approaches (80%) is the major factor for WS perception as given in Figure 49.

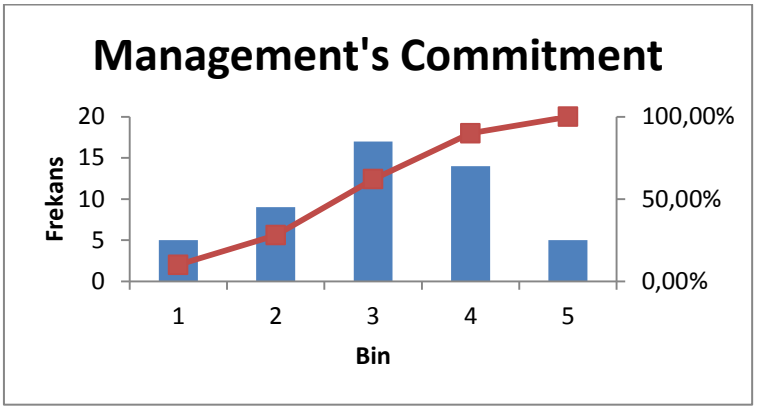

Figure 46 - Management's Commitment on WS Implementation

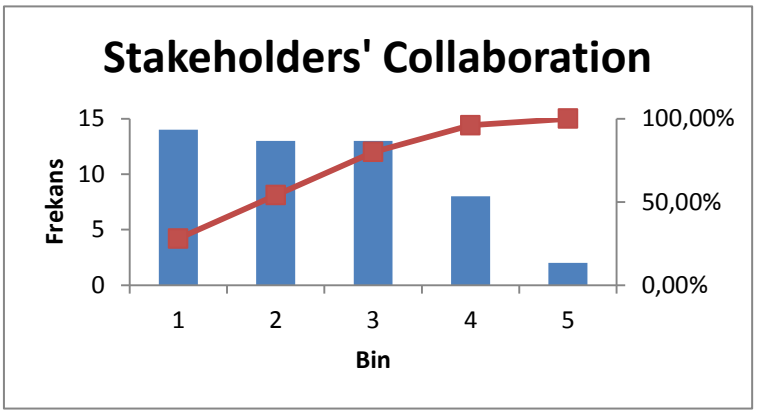

Figure 47 - Stakeholders' Collaboration on WS Implementation

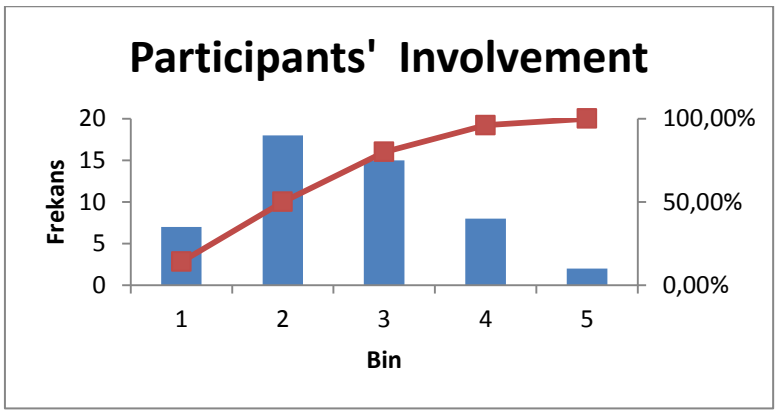

Figure 48 - Participants Involvement on WS Implementation

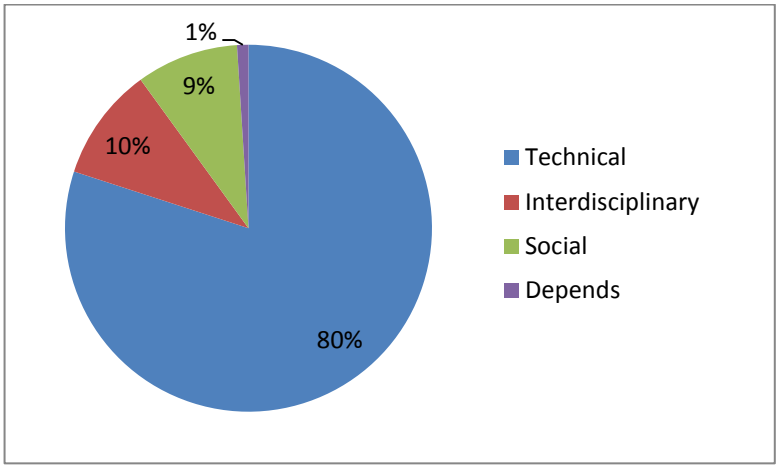

Figure 49 - Main Approaches for WS

Participants are required to name and assess the dimensions of their WS in accordance with their WS perspectives. Management Dimension was prominent with the highest score, 4.58/5.00 as shown in Figure 50, whereas Organization Dimension's importance were almost neglected with 3.85/5.00 as shown in Figure 51. Technology Dimension's score was 3.90/4.00 as shown in Figure 52, whereas Information Dimension got 4.40/5.00 as shown in Figure 53.

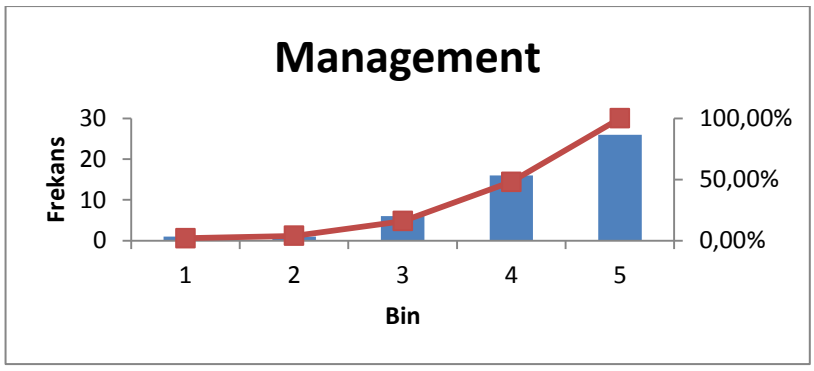

Figure 50 - Importance of Management Dimension in WS

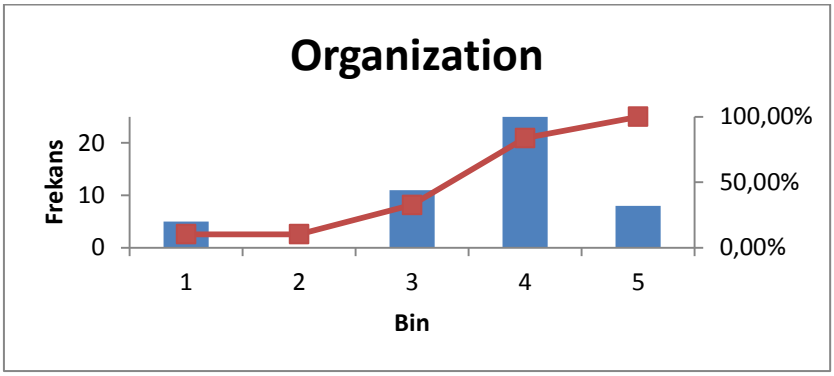

Figure 51 - Importance of Organization Dimension in WS

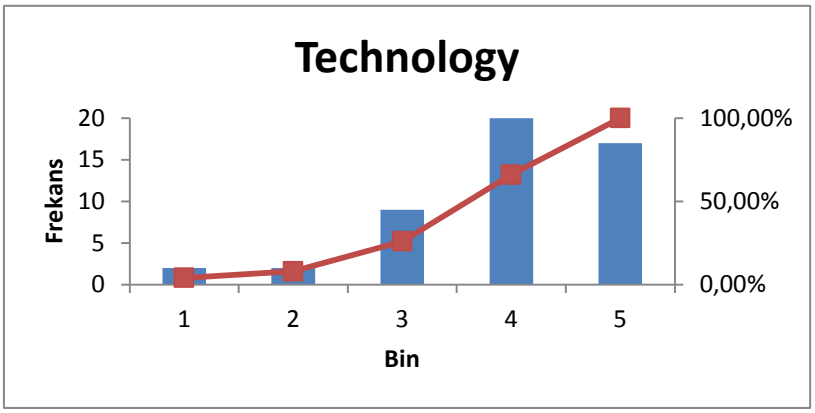

Figure 52 – Importance of Technology Dimension in WS

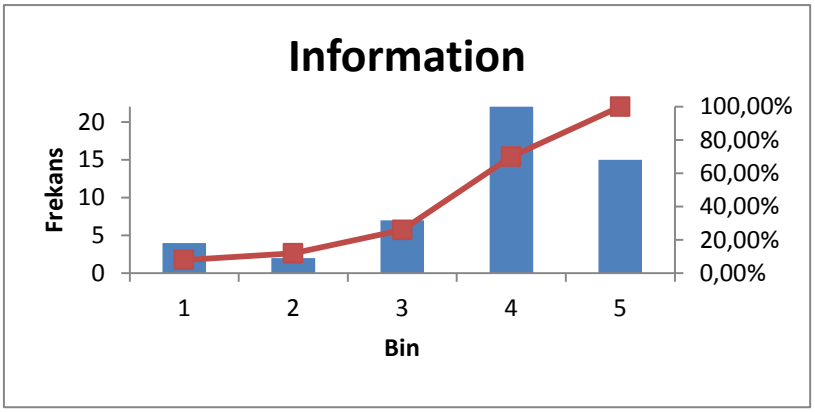

Figure 53 - Importance of Information Dimension in WS

5.3.2 Interviews

During the Survey, Participants were left alone with the questions, without any explanation or dialogue for the objectivity of the results. After finishing Survey, they are interviewed separately in detail over the survey questions again. At the begining of the interviews, participants were first introduced to WS Concept, WST and WS Guides. Then they were required to define their WS in academic jargon as much as possible. Most of them were only able to give its contents of their WS, rather than a systematic definition for their WS.

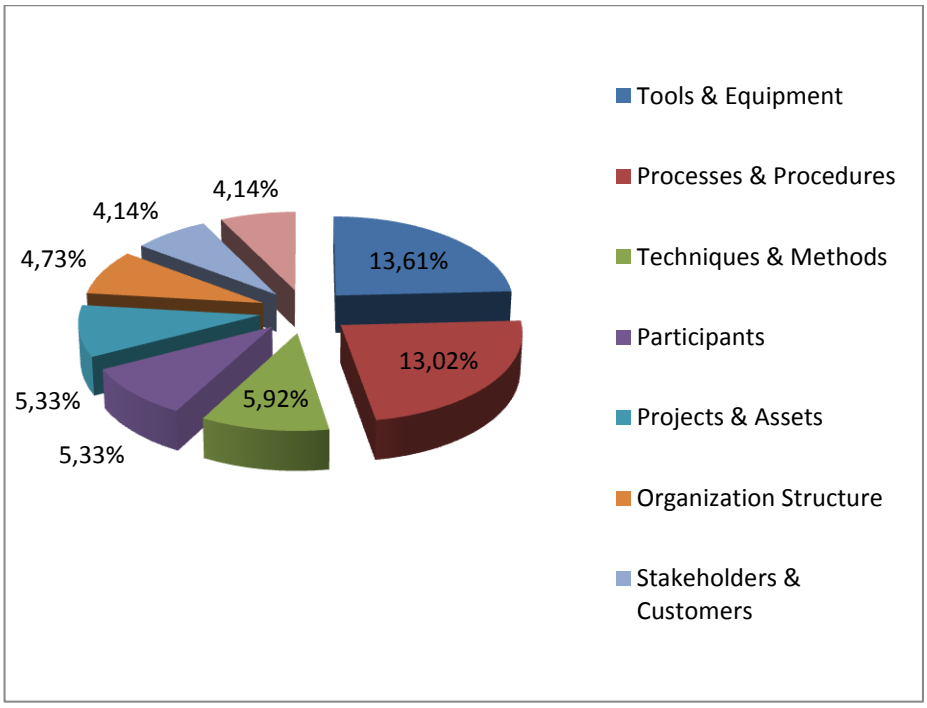

Figure 54 – WS Perceptions

The majority replied as Tools & Equipment (14%), BP & Procedures (13%), Techniques & Methods (6%), Participants (5%), Projects & Assets (5%), Structure (5%), Stakeholders & Customers (4%) and Infrastructures & Facilities (4%) for their perceptions on the WS they execute their work or conduct business. The answers showed an excessive technical perspective as shown in Figure 54.

After defining their WS Entities, Participants asked to evaluate their WS Dimensions. Only few participants were able to mention about Management and Technology Dimensions clearly, without being able to define them precisely. Management was mostly taken pointed as Managers, and Technology with Tools. With high majority, Information was perceived as an entity embedded within Technology Dimension. For this reason, Organizational Learning and Knowledge Management Concepts were overlooked. None of the participants offered an additional dimension than the four given in the HWSF. With the HWSF definitions, all participants claimed that the four concepts are good and enough to define WS

Dimensions and aid WS activities efficiently. The interview enabled Participants to visualize and define their WS clearly. At this step, the question on WS Approaches is re-asked and their answer dramatically changed to interdisciplinary approaches, 48% as shown in Figure 55. Still, a minority of the participants who had a well understanding and experience with WS Concepts and Guides, the major and first answer was “interdisciplinary approaches” and “depends” for WS.

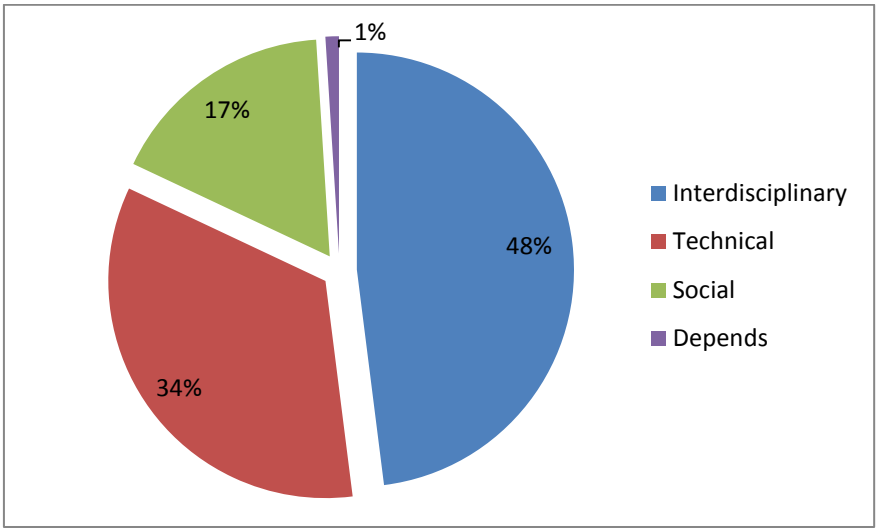

Figure 55 – Vision of Participants on WS after Interview

Participants clearly mentioned the WS Guidance demand and converged on the following major criteria for WS Guidance usability that existing guides lack: Clear Goal Settings with High Level Comprehensive Activity Area Definitions (21%), Descriptive (in addition to informative and normative) Activity Definition by Relating and Mapping them (17%), Visual Support (with graphs, tables, figures and flowcharts, 11%), Systematic Approach (showing the big picture in one view, top down hierarchy with WBS, 9,5%) Contribution of field expertise, best practices and inclusion of ‘know how’s (in addition to ‘do what’s, 8%), Inclusion of samples (case studies, use cases, examples, 7%), and Business Context Coverage (6%), as given in Figure 56.

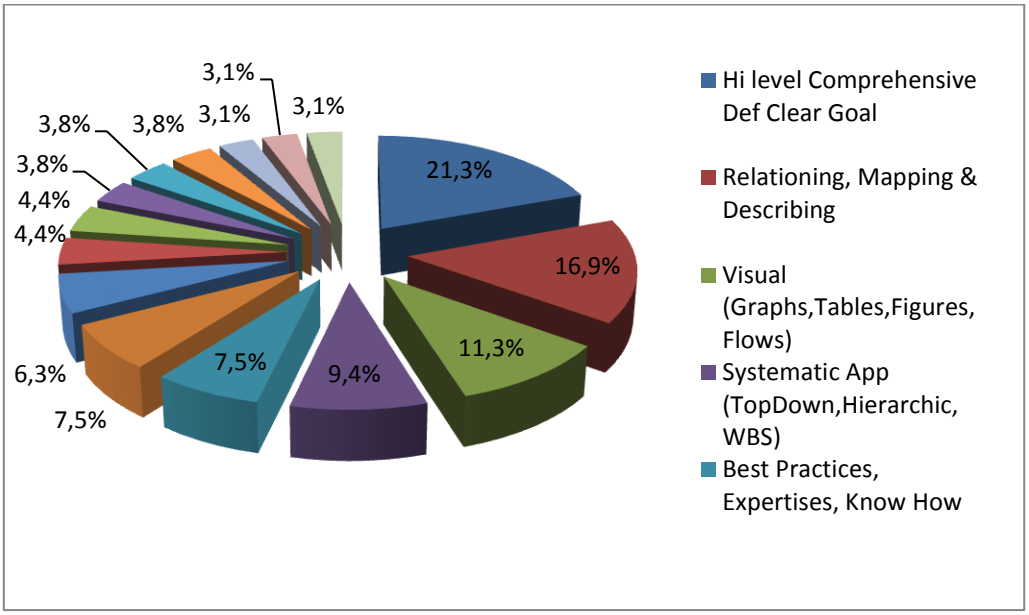

Figure 56 - Vision of Participants on WS after Interview

In addition, there were some suggestions at minor range, but still valuable to mention with participants' own articulation, such as strategy; reasoning for adoption and implementation; glossary; agile & lean support; traceability, consistency and integrity; process definition format usage; roles, states, triggers depiction; R&D and technology trend analysis support; and lifecycle phases and processes alignment.

5.3.3 Analysis of the Field Study Results

The diversities of the participants among their years of experience, positions on management level, and fields enabled the objectivity of the survey and interview. In parallel to objectivity, the sample data set in this study has a weight on field (Engineering and Technology Management) and sector (Public and Foundation). This condition is especially created in order to analyze WS Activities and Guidance in these fields and sectors. Similar works have already been done with other focuses in private sectors and service / support fields, like IT, Service, Health and Education. Due to the nature of these differences, the results of the previous works are specific to their fields and sectors mentioned. Hence a study which focuses on Engineering and Technology fields was necessary. [95], [96].

Still, participants from private and academic sectors, and supporting and consultancy fields, are included in the surveys and interviews as much as possible. In the data set of this study, there is a high portion of Participants' who are performing post graduate academic studies (either Masters or PhD) or already graduated those degrees. This situation supports the academic vision in this study a lot, although the ratio of the (pure) Academic sector seems 1%. Additionally, this situation supports the focus as well, as the post graduate studies are mostly on the same field.. Also, participants working as senior consultant for WS Guidance have a good ratio among the participants both in quantity and quality. At the same time, these consultants also represented the private sector vision in this study.

Majority of the Participants with majority have awareness on the existence of the concepts regarding their WS. Mostly they mentioned and defined WS Perspectives and some explicit WS Entities. But they were not so clear on the exact WS Entities which may be instanced by the perspectives they have less experience. They were weak on the classification of the WS Entities (dimensions and levels), and WS boundaries. For this reason, the answers vary dramatically for ideal and practical cases. The changes of the answers given first in surveys and then interviews were verifying the demand of interdisciplinary approaches guiding.

Awareness of participants on the existing business activities seemed to be caused by the common experiences of well-known standards and models like ISO 9001 and CMMI. But most of the participants have no clear idea on what a quality system or a maturity model is for, if their corporation is or will be assessed accordingly, and how they are incorporated within these activities. Some participants also mentioned that these activities belong to other departments (like Process or Quality Management) and they have no responsibility on. In accordance, fewest participants knew exactly the concepts of Business Goal, Mission, Vision, Policy and their instances in their corporations. Scores regarding Goal Definition, Goal Activity Correlation and Management Commitment are slightly over moderate and in line with the Management Initiative Motivation score for WS Decisions. But the levels of the rates regarding goal, activity and definition correlations show a break in this line and call for critical improvements for paying attention on Organizational Demands and enabling Participants' Involvement. This result also verifies the serious demand of socio-technical systems thinking about their WS.

For the current WS Activities, mostly Systems and Project Management activities were chosen. For the expected activities a cumulative of Program and Portfolio Management was dramatically high followed by Business Process Management. This was interesting, because within the Participants, the portion of application or field specific engineers with Technical Approaches perceptions for WS was notable. Participants were able to mention only Software Engineering easily as an Applications Engineering fields, and separate from Systems Engineering.

This situation is analyzed in deeper during interviews and found out that most of the Participants working on application or specific engineering fields know the activities on project or organizational management by name due to their popularity of that time, but do not clearly know what they are for and how they contribute to. In reality, they do not want to interfere with them either. Lack of definition and relation ability is still true for their own activities based on engineering or technical disciplines as well. For this reason most of the engineering Participants converged to Systems Engineering. Only Software Engineering Participants were able to clearly define themselves separate from Systems Engineering. Relatively well known and common usage of the guides in SW Engineering field aiding even other engineering fields came out to be one of the important reasons of this result during interviews.

Most of the Experts were not sure at first sight about probable guides for their WS, although they answered related question in the survey and work with specific guides

on their specific processes. At the beginning most participants were not sure about their WS Guides family. Only a minority was able to mention about their guides clearly. In general, WS Guides converged mostly to procedures then followed by standards, models and regulations in the interviews. This is taken as the verification for the demand of WS Guidance, and especially the demand for the WS Guidance Awareness, in order to analyze their work not as a specific tool based process but as a socio-technical work system supported by interdisciplinary approaches. As a summary, the results of this evaluation strongly verified the problem domain definitions and solution offer presented in Chapters 1 to 5.

In the selected sectors and fields, there are exhausting practices of Engineering and Technology Management activities. These activities strongly refer to various guides in different forms, like standards, models or body of knowledge. And as mentioned, these were mostly routing from the utilizations in SW and Information Systems fields to Engineering and Technology field. During surveys, ISO 9001 and CMMI were mentioned excessively for the guides followed. Fewer ones also added PMBOK, EFQM, and other standards. Very interestingly, Participants were only aware on CMMI Certification. And for near future, participants plan to follow CMMI and Systems Engineering Standards for WS guidance. During the interviews, this situation got clearer. They were almost unaware weather they are or will be certified on other guides they follow, what, how and why a certification would be held. It was totally perceived as a subject of some organizational units dedicated to process improvement or quality assurance and had nothing to do with the real activities of the corporations.

The main reasons for such disconnection are supported as the low usability, definition and coverage quality of the existing guides those cannot be correlated with the existing activities of the corporation. Such guides do not help participants to understand business goals clearly, hence align and harmonize activities accordingly. The situation leads ineffective benefit costs ratios on WS Activities, the decisions on which are taken with Management Initiative in majority. That's why; the Management Commitments stated on WS activities are high, but very low and Stakeholders' Collaborations. Statements without acts and collaborations decrease Participants confidence in WS Activity and trust in Management, hence dramatically decreasing Participants' active Involvement. During interviews, it is cleared that Management Initiative answer for main WS Activity motivation was the practical case answer. For ideal cases, participants converged dramatically on Organizational Demands (like culture, capability, and competency) to be the motivation of WS Activities.

The mentioned disconnection also weights technical approaches in WS and disabling socio-technical systems thinking. There are plenty concepts regarding WS well mentioned by the Participants. But mostly their meanings and utilization are not clear to them. They were not exact where the entity they mention most lies in their WS, how it is related to other entities etc. with this approach. Management is mostly understood as administrating existing operations. Information and Organization Dimensions are perceived either with high underestimations or embedded in the

former dimensions. All these direct Participants to analyze their WS with the most concrete tools coming from the Technology Dimension.

During surveys and at the beginning of the interviews, Participants had a hard time to visualize their perspectives on WS. WS was mostly perceived as tools and equipment in this trial. Participants were clear neither on the systematic approaches how they conduct the work and collaborate with other parties, nor WS Concepts. In order to gain deeper information on this, Participants are first asked how they perform their work, with which constituents exist in the systems the work is conducted and if there are any service or information packages they receive or create for their work, during interviews. These questions helped the participants to visualize their WS by themselves objectively, without directing or biasing externally. As a following, the questions asked in the survey are revisited in the Interviews. All these enabled Participants to see how they perform their work, what their WS and components are; how their WS are dimensioned and leveled; how their WS entities are positioned and related.

With this objective enlightenment, Participants converged to socio-technical systems thinking demand on their WS. The main need for the correct results of WS Activities, such as implementation, integration or improvement, correct definition and visualization of WS is realized. For such realization, correct guidance is required. The nature of correct guidance is drawn with the following features; high level, conceptual, interdisciplinary, systematic, and best practice supported. The HWSF is analyzed by the Participants and it is absolutely found fully content and enabling new frontiers for WS applications. According to them, all entities were given exactly with good definitions and relations complying with good features of the guides defined by them previously. Observational Evaluation Results verified the gaps in the Business Environment today, and its full redress with the HWSF. These results created the bridge to Experimental Evaluation.

5.4 CASE STUDIES

WS cases set forth by applying the HWSF in participants' former work done, including Organizational Transformation, Technology Adoption, Business Process Re-engineering and System Maturity Assessment activities. All of them are stated to be corporation wise and set upon strategic decisions by executives. Participants are first requested to state the history of the WS Activity selected and its post effects. Later, they are requested to analyze the total lifecycle of the activity with respect to the HWSF. As the HWSF is applied to analyze former works done, these case studies hold a retrospective field study vision.

5.4.1 Organizational Scheme Change

In this WS Activity case, senior management, which is very new to the corporation, has set a strategic decision on organizational scheme change. Upon setting, the decision was not formally broadcasted to the whole corporation. The tailoring mostly occurred closed to the vast of the corporation. Excessive entrustment and

authorization is carried out from outside of the corporation. Changes in the names, heads and positions of the departments occurred. With not an exact formal modality, the reason of the decision was later acclaimed as reaching the Business Goals by answering the Market Needs and Regulations. Dramatic decrease in the business goal clearness, participants' involvement (and motivation), activity efficiency and effectiveness, increase in the number of the heads and management commitment statements are reported by the participants as post effect. Participants analyzed this WS Activity according to the HWSF, and the following statements were the results.

- Environment

For Organizational Change case, any demand routing from the Business Environment entities (like Business Concepts, Contexts or Models) is not observed. Regulations, Market Trends or Customer Requests existing in the Business Environment of that time had also no issue with Organizational Change also.

- Management

In the HWSF, the Business Goal is the Result of to the Strategic Planning and Management Process governed by the Senior Management Level. Participants stated that the Business Goal of the Corporation is found to be too wide, even for covering the future work plans of the corporation. The communication for the reason of the change was defined as adapting for the business goal. Any Organizational Change with respect to this goal was not found irrelevant. The limited form, latency and inefficiency of the communication was adhered as the Senior Management's lack of foresight.

- Organization

According to Participants' Statements, the former Scheme before change was not well accepted in general all over the corporation. There was a so-called matrix structure in order to balance project and functional groups. But this scheme and the authorized participants could not aid the harmonization of project management and technical leading. Most of the participants were not familiar with organizational and behavioral disciplines needed the former scheme to be explained in detail regarding units and roles (including heads, leaders, representatives etc.). Less number of participants who has encounters with social disciplines was supporting improvements including re-organization.

The *Scheme* change was far away to cure the issue. It even increased the diversification of two main directorates forming the matrix form, rather than harmonizing them. Besides, some wrong positioning of some organizational units in the scheme was observed. Some process areas, which should be kept in different units for the sake of their independence and objectivity, were put together in same units. Similarly some units were not put under the functionally related directorates.

The *Culture* of the internal environment is assessed as horizontal hierarchic with many small research groups, but the scheme offered a vertical hierarchy with stronger matrix form. The *Communication* of the Organizational Change activity is found limited and weak by the Participants. Participants claimed a corporation wide broadcast would enable Participants Involvement that would support the re-organization and Management Commitment.

This progress had dramatically increased the number of the *Roles* along with the units. In accordance with the units chaos in the scheme, there were also many roles, like unit heads and functional responsible and author roles, which should be merged or positioned in different units. The *Skills* of the newly authorized participants were not suitable for the roles. New authors or responsible actors did not have related experience and knowledge on their new roles. Additionally, there were new entrants to the corporation. These new comers were authorized for managing roles, much before enough than a period of time for them to be recognized by former ones.

- Information

The knowledge and experience of the authorized Participants about the corporation, corporation working field and their roles were extremely low in the average. The Participants having suitable level of knowledge and experience needed to tailor them for the corporation culture and new scheme. This accumulation disabled authorized participants' acceptance and respect in corporation wide.

- Technology

There was no technology entity activity during this WS Activity.

5.4.2 Technology Adoption (TA)

In parallel, senior management also started adopting necessary technologies for requirements, configuration and project management. The quality and efficiency of the decision analysis and communication process was the same as defined in former WS Activity. Without an exact formal modality, the reason of the decision was later acclaimed as reaching the Business Goals by answering the Market Needs again. The decision included acquiring a system for harmonizing project management and system engineering processes in one platform. This WS Activity was very welcomed by the highest majority of the participants at the beginning. Because the systematic approach demands on project management and systems engineering processes and their harmonization were necessities for all participants.

- Environment

The alternatives of the systems those may answer the business need was analyzed comparatively. The systems utilized by sister or competing corporations and stakeholders were investigated also. Before the related strategic decision, this market

analysis part of the work had started already for a new technology project's a purchase order preparation on Product Lifecycle Management. In this activity the environmental analysis are well established.

- Management

Although, there was a plan to perform TA for a specific project, the decision on TA has been extended for corporation wise. The communication for the reason and the methodology of the adoption was limited, late and inefficient again. In addition formal entrustment for this WS Activity was not clearly done. Hence, the engineering team who had started market analysis continued to work on the activity. Later, in a specific meeting, another group related with project support process area was entrusted orally for this TA activity. Since the beginning, the new orally entrusted group had not encounter to the on-going TA activities. The new group first stopped the ongoing activities and later decided on the system for on their own. The selected system was not one of the first two systems strongly supported by the engineering team. Participants perceived the Senior Management's strategic decision for expanding the TA activity from project level to corporate level as a very positive action. But the communication, entrustment and handover of the TA were perceived as a total catastrophe caused by the atony of the Senior and Middle Management.

- Organization

The first team was formed of engineers who wanted to perform their processes in a systematic way. Hence they were looking for a system that can support systems engineering perfectly with requirements, configuration, design and verification applications. Their lack of systems engineering and engineering management experience caused long latency on their decision analysis and resolution process for selecting the system. But the detailed market and technology trend analysis were adequately good and acceptable. The second group was dedicated to supporting process areas of the organization. They were formed by the new comers. Their knowledge on the corporation's culture and business context, the business need of the engineering team were not adequate. Besides, their experience was not also related to the field they were authorized now.

- Information

The entrusted group did not have a related university education or former training for such a TA. As soon as starting the corporation under investigation, they immediately have taken plenty of conceptual trainings on organizational support process areas. But for most of them, there was not enough the time to apply the things learned in the corporation. Hence, exploitation of the trainings was very low. The entrusted group members had seriously low level of knowledge and experience to be the owner of this activity. The engineering team was well educated on specialty branches like electronics or mechanical engineering etc. But their trainings on team building or systems engineering were totally lacking. Many of them were even

thinking that systems engineering is the design of the subsystems each one is responsible with presentation of the designed artifact in academic meetings or corporation visits. Besides, the engineering team was aware of the lack of team working but no motivation to cure it.

The TA was started on the information created by the engineering team. But it is learned that the information was not recorded formally. So it was not only transformed into corporation knowledge by several iterations but also not archived as lessons learned.

- Technology

The technology the corporation needed was relatively easy to define as a system offering necessary platforms and applications in order to define and harmonize project management and systems engineering processes. The gap of well defining the related BPs, which are entities of Technology Dimension in the HWSF as well, was not healthy. So the right BPs could not be pointed either. This wrong definition of BP, has led wrong implementation which caused acquiring technologies which are not suitable to answer the demand.

For example, while the engineers were looking for managing requirements, the new group directed the acquisition to a configuration management system. After purchase, the new tool was not used by any group in the corporation since 2 years and so on. Besides, a minority group in the engineering team claims that they had continuously mentioned to all peers that before buying any other new technology the improvement, revision and full adoption of the existing requirements management system in the corporation, which is partially used in some groups, is mandatory. 3 new WS platforms and 1 WS platform renewal were bought for the related corporation wide TA with the decision of the entrusted group and senior management. The renewal was minority engineering groups' recommendation on requirements management. The remaining new platforms those were opposed by the majority of the engineering group were to serve configuration, design and project management. Before successful implementation is foreseen the following WS activities had started. The trial for TA became a never ending story in the corporation. The entrusted authorities were inexperienced and having only advertorial knowledge in the field of technologies purchased. Their adoption including implementation, utilization and acceptance by participants were not governed and managed by them. For this reason they wanted to pass the responsibility to the IT department after purchase. IT department could only support the infrastructure level as normal. The engineering teams did not take over responsibility of the new WS platforms.

5.4.3 Business Process Re-Engineering (BPR)

Along with the new technology platform and tools, the methodologies of the work done is said to be defined and implemented on them.

- Environment

In the Business Environment, there were plenty Stakeholders having high maturity on their capabilities. They were also well certified by standardized organizations for their BPs. Their main motivation for BPR and certification was mainly customer requests documented in project and work contracts. The stakeholders were happy with the existing project and engineering work and information flow of the corporation. Hence, they had no extra request on any WS activity regarding BP improvement in the corporation at that time. In parallel, there were no market trends or other environmental constraints (like contractual definitions, regulations and legislations that business contexts are bounded etc.) influencing such WS activities also.

- Management

As continuation of the TA activity, senior management decided for a corporation wise BPR, labeling it as a strategic decision in order to answer the needs posed by business environment, stakeholders and markets. The decision, analysis and communication process occurred in the same way like Organization Re-structuring and TA cases. New process owners were assigned by new unit heads suddenly. This assignment is done without evaluating the mentioned process was needed by the corporation in order to support their business goal or not. The process selection is performed with respect to the new unit heads' former job experiences. According to their handling of the issue, these experiences were not only found as belonging to another business context, but also very poor even for another business context.

- Organization

The entrusted process owners, either new or old in the corporation were advertised as having deep experience and knowledge on the field and context of the corporation. In short time, the participants perceived that the entrusted process owners did not have any experience on the processes they are assigned, process engineering or organizational management. The participants with pretty experience and knowledge on the corporation's environment and organization, and BPM were excluded during Organizational Restructuring WS Activity. The process owners could not perform BP definitions or governance. Existence of Program/Project Managers or Quality and Process Managers with no PM or QM & Process Management experiences respectively was a big fault for the execution of Senior and Middle Management Processes. After wrong definition of the organizational structure and TA failure, BP Definition catastrophe increased participants' lack of confidence lack, hence their involvement. For the allocation of the BPs, it had been tried to follow the new Organizational Structure. But the problems of the structure became more visible and deep, with BPs and function descriptions activities. In BPs, many activities were calling wrong units or roles. This was creating either repetitions, or conflicting, or unsupported activities.

- Information

The authorized Participants were acting as unit heads, process owners or function representatives. The information levels of them on organizational issue resolution and process management were far less then little. There occurred a chasm in the perceptions for the work under scope and the definition of the work under scope by means of BP Description. This information level with the existing knowledge and expertise, led most participants to perceive these two works differently. For them the former one was their work. The latter one was just bureaucratic documentation work, which the new comers were for, and engineers were not related with it at all. Hence the big lack of governance and participants' involvement, which began to occur during Organizational re-structuring and TA, was maximized in BP activities. BPs were mostly defined and documented by participants other than the process owners. These participants were explicitly motivated but very novice. Any experience or knowledge existing could not be institutionalized.

- Technology

Some of the published BP descriptions and supporting documents were composed by rough translation of main bullets of well-known standards or body of knowledge. Most of those documents were also exported from other corporations which are good at process maturity and description but working totally in other business contexts. During this exportation tailoring was not established. Even in some of the templates former corporations' logos or legends were forgotten. In BPs, many activities were calling wrong units or roles and technologies those were to be adopted but could not be achieved.

5.4.4 System Maturity Assessment

- Environment

Same conditions of the Environment existed for the activities defined in Chapters 5.4.1, 5.4.2, and 5.4.3.

- Management

Same conditions of the Management existed for the activities defined in Chapters 5.4.1, 5.4.2, and 5.4.3.

- Organization

Same conditions of the Organization existed for the activities defined in Chapters 5.4.1, 5.4.2, and 5.4.3. Additionally, a team to support assessment was to be built with the name Assessment Team. Team's main responsibilities were to assist the external assessor to understand the organizational structure and roles; assess the processes with respect to reference standard's criteria; check for business goal

alignment, and participants' role & skill fit. The team members were selected by the senior management and quality management representative, without consulting the candidate members. Members were later informed by a memorandum that is broadcasted to all participants. Upon to the question on the process and reason of the selection posed by the members, the representative asked it was the administrative discretion of the senior management according to the recognition of members' merits.

Ideally, the assessment team was to be independent and objective. For this reason, there should have been no member who had worked on the process definitions and executions. But with another set of administrative discretion, the process engineering and quality management representatives were also inserted to team, which was surprisingly accepted by the external assessor. Participants entrusted with the quality and process management activities, freely asked this representative in the team, for their wills and opinions about the assessment. The representative was novice and weak not only on the area representing, but also organizational issues and formal communication. During all lifecycle, this situation affected assessment negatively.

- Information

Neither representatives/heads of quality and process engineering nor the majority of the team members had any knowledge or experience on quality management, process engineering or system assessment. The heads and representatives even lacked the compulsory beginner level formal trainings. There was an examination for the acceptance of assessment team members. Half of the entries had failed. The chasm due to the lack of experience and knowledge became more concrete and deeper with this WS Activity. Because most of the unit heads or process owners did not only govern the unit and process duties but also perceived that such WS Activities, like TA, BPR, re-organization or assessment were totally independent and extra issues those should be done without them. Excessive number of unit heads, function representatives to fill the excessive number of units and roles was aiding this unconcern of governance issues.

- Technology

The technology of this WS activity was intended to use the ones mentioned in TA activity of Chapter 5.5.1.5. Regretfully, implementation of those technologies was still not finished, having serious faults. There had been various disruptions and delays on communication, storage and reporting because of the selected new technology's unsuccessful adoption. This situation was also experienced during many other project and process executions of the corporation.

5.5 EXPERIMENTAL EVALUATIONS

In former evaluations of the HWSF work, the demand of a high level conceptual framework guiding researchers and practitioners in their WS activities was

determined concretely. In addition to Field and Case studies, further evaluation of the HWSF is performed with Experimental Evaluation. In this evaluation, the HWSF is studied in detail with Participants according to its usability as a main non-functional quality attribute. The environment control is achieved by studying the HWSF with respect to the experiences and lessons learned elicited during Observational Evaluations and related analysis.

Participants attended to the experimental evaluation of the HWSF are experienced in more than one of the WS activities, like TA, BPM, Organizational Management and System Assessments. According to the participants, the usability of the HWSF was found very high, with a score of 4,85/5,00. The biggest question posed by the participants about the HWSF was regarding the differentiation of Management and Organization dimensions, and Technology and Information dimensions. Most of the participants declared that they are the same and proposed merging them as an improvement proposal. After re-defining them the components under these dimensions, the concepts and meanings they hold, how they are allocated and related in detail, all ambiguities were cleared.

Commonly, the participants were also interested in why BPs is allocated under Technology dimension. They used to have it as a bureaucratic documentation work, which is totally a managerial asset and nothing to do with technology or engineering. According to HWSF, the meaning of BP is re-declared to them. BP is more than formal documentation; it is the recording of the techniques or methodologies as organizational knowledge that is the result as the transformation of organizational unit or working group learning enabled by refining the individual information and experiences.

Moreover, comment on merging Information and Technology dimensions came from the participants, with the reason of high demand on technology for processing, archiving and retrieval of the technology. When they are declared about the levels of information, and how information based business is active today, the reason of separate dimension for Information was accepted. Besides, the high demand on technology is not only valid for Information dimension, but also for all WS dimensions and components. When the participants are reminded about this fact, perception on separate Information and Technology dimensions were reinforced, and the usability of the HWSF as a redress for the existing gap in WS activities were assessed as very high.

Their unique concern in general were regarding the organizational cultures and individual habitual customs of not well planning for WS activities, in where determining and utilizing suitable guidance necessity is skipped easily effecting the later phases after planning for WS activities. It is analysed with participants that the holistic and high level vision of the HWSF would also enable users to see the present and future constraints of the WS activities totally, like starting from context and strategy to the end WS Result.

5.5.1 TECHNOLOGY ASSESSMENT

The participants analyzed the TA experience of the corporation with the HWSF. This aided them to assess the existing TA situation, define failures, problems and successes regarding TA, propose resolution options and improve the situation throughout their corporation.

5.5.1.1 Environment

TA experiences and technologies utilized in the Business Environment and collaborating Stakeholders are reviewed again, this time with the aid of the HWSF, taking all concepts of environment, context, model for business. For software development, most parties utilized the corporation's former configuration management tools those were used before new technology purchase. For requirements management, similarly the platform existing in the corporation was in use in the stakeholders and other corporations in the environment those constitute and shape the business contexts in the environment. For design management there were various platforms and applications in the Business Environment, even in the same or very close Business Contexts, due to the varying specialty engineering disciplines enabled.

5.5.1.2 Management

The balky authorization of the TA activity is resigned and new authorizations for TA and supporting activity is done in several management levels in accordance with the HWSF entities. This action aided the TA problems resolution for sure, but due to uncorrected organizational structure its cure was very limited.

5.5.1.3 Organization

First of all, the Infrastructure and platform support responsibility is given to IT department for all the technologies adopted. The responsibility of the renewed WS platform, which was already serving requirements management with previous revision, is transferred from the project support unit to project management unit. With engineering units' technical support, this WS platform is effectively used in the projects of the corporation. The responsibility of the new project management platform is given to project managers. The responsibility of the design management platform is given to engineering units.

5.5.1.4 Information

The former trainings taken on the platforms were more like presentation demos and introductory level. The information level about the platforms has been enhanced with on the job trainings. By this way not only the information level is increased but also they are transformed to a level of knowledge.

5.5.1.5 Technology

The new platforms bought by the decision of the project support unit, are re-analyzed in detail by the engineering units with respect to the HWSF. The

configuration management platform is found not suitable for the existing and possible business contexts. Besides, it is found out that its other functions else than configuration management, like issue tracking was also existing in the capacity of the other new platform purchased for project management. The engineering team has decided that the new purchased WS platform for configuration management is totally unusable and the existing platforms they used are successful enough to manage their configurations in the projects.

5.5.2 BUSINESS PROCESS RE-ENGINEERING

5.5.2.1 Environment

There was pretty successful BP in the Environment of the Corporation. But these adoption ones were serving for a complete different business context based on application software and web services. Hence, they were not suitable at all for the corporation. Some of them were tried to be adopted directly, without tailoring within the corporation during BPR effort detailed in Chapter 5.4. With the aid of the HWSF, the Environment is reanalyzed. In the Business Environment, there were many stakeholders and sister companies sharing the same or extremely close Business Contexts, even taking roles in the same Business Models and Concepts with this corporation. They had very usable processes based on their very valuable best practices, continuously enhanced with experiences, lessons learned and organizational knowledge. The new process owners interacted with these bodies. Both stakeholders and sister companies agreed on performing collaborative work shops and sharing knowledge and experience for process definition, implementation and improvement.

5.5.2.2 Management

As pointed in Section 5.5.2.1, the process owners for managing BP activities had been revised in accordance with the HWSF's Participants features like; skills, abilities and closeness to the related fields. This was a dramatic step, but should have been supported with enhancing the team work which will be discussed in Chapter 5.5.2.3.

5.5.2.3 Organization

Although the managers for the BPs had changed, this brought insufficient improvement. The engineering teams' involvement in BPM was not sincerely achieved, as most of the unit heads remained the same who were keeping their distance to any WS activity. They were mostly perceived as incompetent in process management regarding either lifecycle, or project or quality management. For sure this brought the reluctance and distrust in Participants, disabling their effective and efficient involvement. This situation was triggering for organizational scheme re-structuring. Still, within this condition some of the new project owners insisted on and enabled collaborative BPM in accordance with the HWSF. This brought the new process owners to be each other's deputy, in order to improve processes together in

collaboration. This cured the big lesson learned during BPR, like the failure of false adoptions or uncorrelated process definitions throughout the corporation.

5.5.2.4 Information

The information gain and enhancing method is planned with collaborating with the stakeholders and sister companies. Workshop meetings are held. Process definitions are analyzed comparatively. These definitions are also assessed with respect to actual best practices, body of knowledge and standards of the business context. The process definitions of the corporation were enhanced dramatically. During this the Information Dimension components, levels and their relations are kept in mind actively. This aided searching for actual process trainings strictly dedicated to their business context. Three sets of trainings are found and proposed to senior management's approval. First one is based on introduction to BPM, followed by Introduction to Systems Engineering. Finally, Specific Engineering Management processes dedicated to corporations' business context. With the aid of Organization Dimension of the HWSF, the collaborative BPM was already started. In addition, with the aid of Information Dimension's vision, these workshops and trainings supported BPM activities, not only in an individual learning way, but also team and organizational learning way.

5.5.2.5 Technology

The WS Results of the TA Case Study (Chapter 5.4.2) for organizational rehabilitation are used as input to this WS Activity. There was no other necessary technology analysis issue for BPM case.

5.5.3 ORGANIZATIONAL SCHEME RE-DESIGN

5.5.3.1 Environment

In the Business Environment, there were many stakeholders and sister companies with very different organizational schemes. Some were having vertical hierarchy, others preferred horizontal distribution. None of these corporations were defending theirs as the best, even confessing the strong and weak sides of these schemes. But analyzing these with respect to the HWSF, it is found that none of these schemes existing in the Business Environment, external to the corporation had conflicting Duty and BP allocation within their organizational units. Very importantly, the unit heads or process responsibles were selected within the corporation, according to their knowledge, expertise and skills within the organization and the field.

5.5.3.2 Management

Reallocation of organizational units brought the change or convergence of the unit heads. New managers at any level, even middle management level as unit leader or senior management level, have been selected according to their expertise in the field.

The remaining entrustments in all management levels are taken care with respect to organizational culture, field experience, and participants' skills and knowledge.

5.5.3.3 Organization

The senior management had changed just before the Organizational Scheme Change activities defined in Chapter 5.4.1. That senior management was also removed again during rehabilitation activities. Hence the new senior management team had no deep knowledge on the organizational issues other than the unit heads' telling and directions. Still, fast and clear analysis occurred on this senior management level for the high demand on scheme revision. Senior Management requested Executive Reports from the experienced and long time working Participants within the corporation. The reports used the HWSF as referencing guide. With the aid of these reports cures in the scheme has been decided. With this decision the ill-natured design verification and design assurance processes, responsible and units had been separated. The so called business development units were merged in most related other organizational support units, as the corporation need no business development and those units were not doing actual business development. There were other issues regarding organizational unit definition and allocation but due to the constraints posed by the business contexts and regulatory issues they could not be implemented. Without cancellation, they have been issued as open action items for future plans.

5.5.3.4 Information

The level of information regarding organizational issues, their relations with other HWSF entities was dramatically increased by the lessons learned and experienced during the mentioned WS activities as the reflection of the HWSF and all its entities. As mentioned in Sections 5.5.1 and 5.5.2, this time this information was not only in individual information level but also in organizational wide knowledge level.

5.5.3.5 Technology

The WS Results of the TA Case Study (Chapter 5.4.2) for organizational rehabilitation are used as input to this WS Activity. There was no other necessary technology analysis issue for BPM case.

CHAPTER 6

SOLMAZ FRAMEWORK

In this Chapter, a real holistic, interdisciplinary, systems thinking model for institutional process management is designed as an additional work with the aid of the HWSF. The HWSF is effectively used to asses the process concepts by refining their definitions, allocations and relations. This model is prepared not only to guide users during their BPM activities but also to give a foundation for WS Body of Knowledge that is a future work plan based on the HWSF. Before proceeding with the details of the proposed model, it is important to overview the existing situation regarding contemporary models in the market. As explained in Chapter 3, there are various models for WS exhibiting differing views. Among alternatives in the knowledge base;

- CMMI with a more process management orientation,
- PMBOK with a more project oriented view,
- IPMA with project management orienated with accounting and governance,
- ISO 15288/15504 with a more Systems Engineering view closer to Engineering Management vision.
- ITIL and CoBIT are well-known assessment frameworks residing IT field in a more isolated way from the former ones.

Comparatively, CMMI may look more integrated, whereas, 15504 is more SW oriented; as it does not only support 15288, but also 12207. In other fields, IPMA has strong weights and details on Cost Management and HR Management processes and activities, those are overseen by PMBOK. Today, while any industry tries to enhance and develop Business by improving processes, the actors of those industries became a model pursuer for being certified. Most of the time the aim for gaining these certifications is lost, certification solely becomes an aim, even becomes a burden rather than improvement aid. Most companies run for CMMI, ISO 15504, and ISO 9001 assessment and certification. Besides, individuals seek for INCOSE, PMI, IPMA, EFQM or EOQ certifications.

When these models are analyzed in detail, it is easily seen almost all of them gives the main steps of ‘what’ to do. They do lack the information regarding ‘how’ to do in

order to let the implementor tailor the given step according to its corporation. The process areas are not logically sequenced or related with each other. Besides, they may lack balance in dimensions. They may be either strongly mentioning one dimension, while underestimating the other or even totally neglecting one. This situation gives way to a group of unlinked processes. This situation is not suitable and mature to support institutionalized management.

Among all of these, yet there is no standardized common-sense full set of best practices, neither comprehensive leading guidelines, nor complete frameworks with full perspectives. This lack is a well-known problem in this field. There is a need of a guide which would be non-market specific, comprehensive, compact with multi-views, taking all related dimensions and components of management together with a good balance. Hence the need of guiding users with an institutional management perspective, rather than focusing on process families, is very clear.

6.1 INSTITUTIONALIZED MANAGEMENT

In this research work, a resolution to this ill-natured problem is proposed to guide the enterprises, implementers and researchers in the field. The resolution lies on institutional management, serving a holistic, harmonized management for the necessary interdisciplinary processes aligned with corporate goals. The proposal of this research work is, hence, a novel holistic institutional management process framework, with the name SOLMAZ Framework (SOLMAZ-FW) : A Novel Holistic Framework Proposal with the Aid of Work Systems Approach for Institutional Management, Aligning Systems Engineering, Organizational Management And Project Management Processes with Business Goals.

SOLMAZ-FW aims to depict all important dimensions, components, levels and relations of the institutional management. It achieves this aim by harmonizing the necessary processes of interdisciplinary fields; systems engineering, organizational management and program management; with work systems approach. Foundation of these dimensions and their relation are taken as an important key factor for institutionalized management in this work. For this reason, these fields are analyzed in the following chapters in detail, according to the existing guiding lanes.

6.2 SYSTEMS ENGINEERING

The Systems Engineering has been defined in several ways in different sources (like IEEE, ISO, INCOSE etc). Analysing these definitions is vital for depicting the demand on systems engineering. The evolution of systems engineering from engineering management is also an important point to investigate with respect to the connections to neighboring models like process assessment and to project management [34].

Today systems engineering is still in progress, getting converged to enterprise management; hence a corporation working on Systems Engineering has proposed a new concet as Enterprise Systems Engineering. The supporting motivation for this

progress is sure the emerging concepts and converging technologies discussed in Chapter 3. This evolution also supports our former work, Enhanced Work Systems Framework, for its interdisciplinary and systems thinking nature. The main aim of systems engineering was to identify requirements for a number of processes suitable for usage during the life cycle of a system. This is the reason why all the sampled models have dramatic overlaps, with different point of views and logical sequences.

Various existing and obsolete standards or body of knowledge documents guiding systems engineering field are analyzed thoroughly. They are mainly, the standards of International Standards Organization (ISO 15288 and ISO 12207), IEEE's 1220 Standard, handbooks of INCOSE, NASA (with its own stadards on Systems Engineering, Quality Management etc.) and DAU (Defence Acquisition University's Fundamentals of System Enginerring), ESA ECSS Standards Framework, and two obsolete standards, ANSI/EIA's Processes for Engineering a System - ANSI/EIA 632, US DoD's Military Standard System Engineering Management – MIL-STD-499. After this search, it is found that most of the standards are based on the latter obsolete standards.

They all aim to define some processes aiming to aid WS. Some of them are more concentrated on describing the life cycle of a system the life cycle of a system from concept to disposal. Some are more concentrated on development and implementation of a system. While, there are some proposing the processes solely for the management of a system. This makes some guides to cover more are while having less depth, and some others depth with less area coverage.

Among all these guides, ISO 15288 is chosen for this work to be guiding this field. The reason of this choice is its wide basis, detailed and comprehensive description and better ability to be harmonized with other neighboring fields. The framework proposed by 15288 is shown in Figure 57. When ISO 15288 is analyzed carefully, 4 dimensions (Process Families) and 25 Components (Process Groups) are seen. They are respectively Agreement, Organizational, Project and Technical Process Families. The process groups are given from Clause 6.1.1 to Clause 6.4.11.

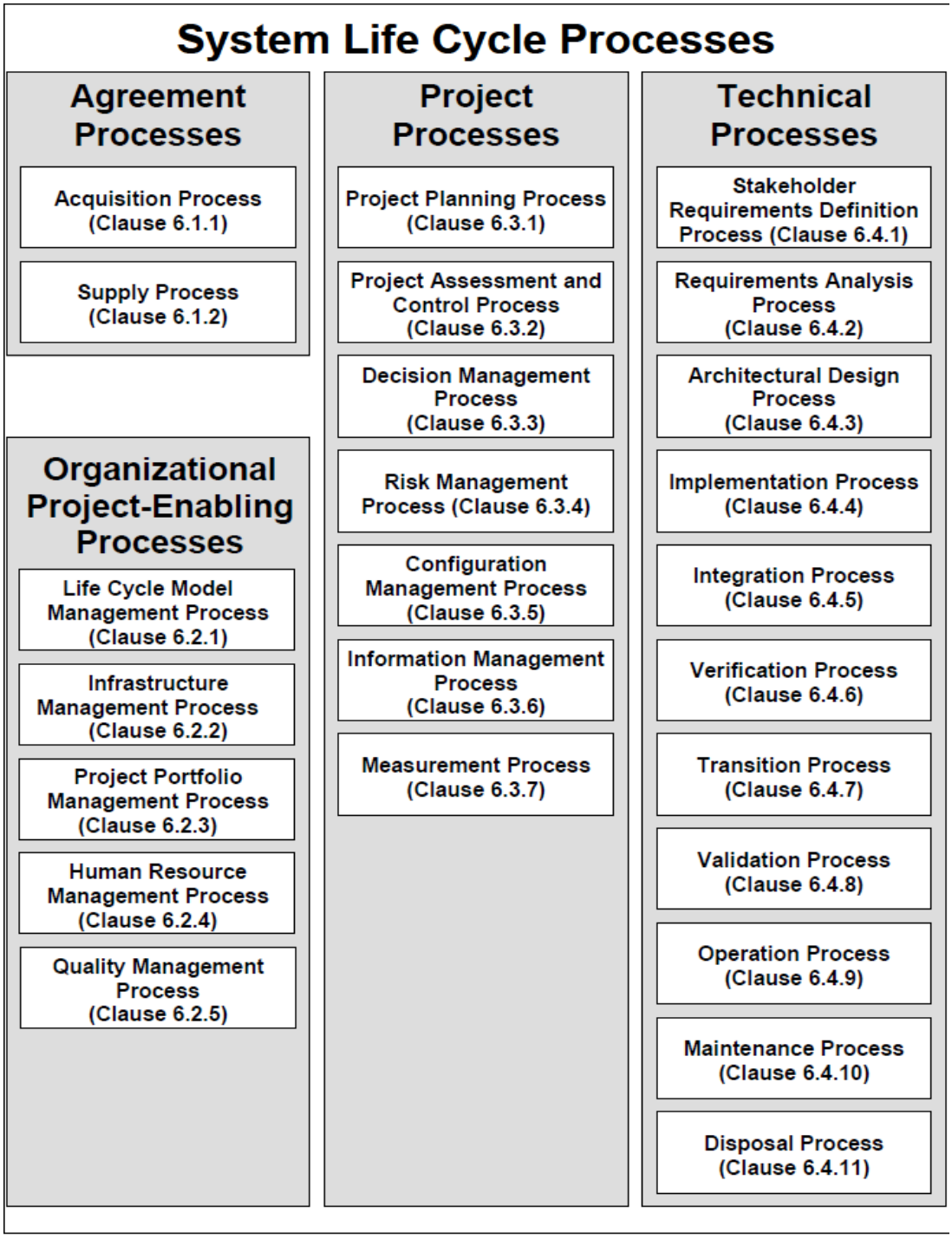

Figure 57 - ISO 15288 System Life Cycle Processes

For SOLMAZ-FW work, Agreement Processes are handled with together Project-Enabling Processes, and both are taken as Organizational Processes. In Table 4, the 15288 processes are grouped according to their nature. O labeled processes support the Organizational Management Processes of the framework proposed in this work. In the same way, T labeled processes support for Systems Management, and P support for Program Management Processes.

Table 4 – ISO 15288 Process Area and Group Allocations

List#	Process Family	Process Group
O.6.1.1	Agreement	**Acquisition**
O.6.1.2	Agreement	**Supply**
O.6.2.1	Project- Enabling	**Life Cycle Model**
O.6.2.2	Project- Enabling	**Infrastructure**
O.6.2.3	Project- Enabling	**Project Portfolio**
O.6.2.4	Project- Enabling	**Human Resource**
O.6.2.5	Project- Enabling	**Quality Management**
P.6.3.1	Project	**Project Planning**
P.6.3.2	Project	**Project Assess. and Control**
P.6.3.3	Project	**Decision Management**
P.6.3.4	Project	**Risk Management**
P.6.3.5	Project	**Configuration Management**
P.6.3.6	Project	**Information Management**
P.6.3.7	Project	**Measurement**
T.6.4.1	Technical	**Stakeholder Req. Definition**
T.6.4.2	Technical	**Requirements Analysis**
T.6.4.3	Technical	**Architectural Design**
T.6.4.4	Technical	**Implementation**
T.6.4.5	Technical	**Integration**
T.6.4.6	Technical	**Verification**
T.6.4.7	Technical	**Transition**
T.6.4.8	Technical	**Validation**
T.6.4.9	Technical	**Operation**
T.6.4.10	Technical	**Maintenance**
T.6.4.11	Technical	**Disposal**

6.3 CAPABILITY AND MATURITY MODELING

Capability Maturity Models played a reciprocal supportive role with some standards in the fields of Systems Engineering, Process Improvement and Project Management. The role and importance of these models have almost converged with those of standards. Well-known samples for these models can be named as; CMMI

v.1.3, ISO 15504, EIA-IS 731, and last but not the least, ISO 25000 SQUARE. For process assessment field, CMMI v1.3 is chosen as a guide, as it is most widely known and followed one in information, engineering and acquisition markets. Like ISO 15288, it covers a wide range of area. It refers to the processes listed alphabetically in Table 5.

Table 5 – CMMI Dev. v1.3 Process Groups and Areas

Process Family	Process Group	Abbreviation
Enginnering	Validation	VAL
Enginnering	Verification	VER
Enginnering	Product Integration	PI
Enginnering	Technical Solution	TS
Enginnering	Requirements Development	RD
Project	Quantitative Project Management	QPM
Project	Integrated Project Management	IPM
Project	Risk Management	RSKM
Project	Supplier Agreement Management	SAM
Project	Project Monitoring and Control	PMC
Project	Project Planning	PP
Project	Requirements Management	REQM
Process	Organizational Performance Management	OPM
Process	Organizational Process Performance	OPP
Process	Organizational Training	OT
Process	Organizational Process Definition	OPD
Process	Organizational Process Focus	OPF
Support	Causal Analysis and Resolution	CAR
Support	Decision Analysis and Resolution	DAR
Support	Measurement and Analysis	MA
Support	Process and Product Quality Assurance	PPQA
Support	Configuration Management	CM

According to the dimensions (process families), the list can be revised as follows according to Project, Process, Support and Engineering fields. In this CMMI v1.3 view, Process and Support dimensions are taken separately. In this work, during

tailoring, the main processes of these two fields are utilized for the foundation of Organizational Management dimension. It is also important to mention the generic goals and practices of CMMI v1.3. These are the efforts for higher level organizational process definitions, those are important to bind process families in the upper level.

6.4 PROJECT MANAGEMENT

Among all mentioned lanes, Project Management is the most famous one. The fame rises due to its excessive abstract and non-technical contents, where the former two lanes are not good enough to define and relate. Project Management Process Families lack technical solution processes. But they give interdisiciplinary solution with schedule, cost, communication and especially lifecycle integration; rather than sole product integration. It also mentions higher level project process families such as, Portfolio and Program Management, those are lacked by other guides.

For Project Management, the mostly followed guides can be named as IEEE/PMI PMBOK, IPMA Framework, PRINCE II. ISACA COBIT and ITIL Frameworks also mentions project management processes for information systems. Among all, PMI PMBOK seems to be the most popular and followed due to its high holistic, interdisciplinary and comprehensive nature relatively. PMBOK has 9 process areas, which are listed below. The list does not require a logical sequence, rather groups of application areas.

1. Integration Processes
   a. Project Charter
   b. Develop Project Plan
   c. Execute Project Plan
   d. Monitor & C Project Work
   e. Close Project / Phase
   f. Integrated Change Control
2. Scope Processes
   a. Collect Requirements
   b. Verify Scope
   c. Define Scope
   d. Control Scope
   e. Create WBS
3. Schedule Processes
   a. Define Activities
   b. Sequence Activities
   c. Estimate Activity Resources
   d. Estimate Activity Durations
   e. Develop Schedule
   f. Schedule Control
4. Cost Processes
   a. Estimate Costs

b. Control Costs

c. Determine Budget

5. Quality Processes

a. Plan Quality

b. Perform Q Assurance

c. Perform Q Control

6. Human Resources Processes

a. Develop HR Plan

b. Acquire Project Team

c. Develop Project Team

d. Manage Project Team

7. Communications Processes

a. Identify Stakeholders

b. Plan Communications

c. Distribute Information

d. Manage Stakeholder Expectations

e. Report Performance

8. Risk Processes

a. Plan Risk Management

b. Identify Risks

c. Perform Qualitative and Quantitative Analysis

d. Plan Risk Response

e. Monitor & Control Risk

9. Procurement Processes

a. Plan Procurement

b. Conduct Procurements

c. Administer Procurements

d. Contract Closure

When studied carefully, with other Project Management frameworks, PMBOK seems to be fairly balanced, including basic fields and processes, and easy to be tailored and harmonized with other frameworks. In this work, the framework offered by PMBOK is also worked in detail and enhanced in order for the design artifact.

6.5 PROCESS CROSSCHECK

When the process groups in both frameworks of ISO 15288 and CMMI v1.3 are analyzed respectively, their similarities, intersection sets, lacks with respect to each other, and constellations within different dimensions are seen. When a fast cross check between these two references are made, the following list occurs with corresponding processes respectively.

In this scheme, mostly the technical processes are correlated with some lacks on CMMI v1.3 side respectively. ISO 15288 has clearly defined the product life cycle from concept to disposal, with more clauses for technical processes. In CMMI some of these processes are either merged; like merging design and implementation in technical solution; or combined; like combining integration and post-product life cycle in product integration, or not mentioned as detailed as in ISO 15288. This makes ISO 15288 a better option for Engineering Management process guidance.

When organizational and project processes families are taken together, CMMI v1.3 and ISO 15288 seem to be highly correlated. ISO 15288, mention on Infrastructure, Portfolio and Information Management as independent components. Not only CMMI v.1.3 but many guides existing are weak about mentioning these components explicitly. Hence, ISO 15288 dominates again on this lane by specialty it offers. Whereas, CMMI v.1.3 is a better solution with detailed views on organizational process definition, focus, performance components. These are somehow embedded in Life Cycle Model component in ISO 15288.

Table 6 – ISO 15288 vs CMMI Dev. v1.3 Process Comparison

15288			CMMI		
O.6.1.1	*Agreement*	Acquisition	***PM***	*SAM*	Supplier Agrmnt.Man.
O.6.1.2	*Agreement*	Supply	***PM***	*SAM*	Supplier Agrmnt.Man.
O.6.2.1	*Organization*	Life Cycle Model	***OM***	*OPF*	Org. Process Focus
O.6.2.1	*Organization*	Life Cycle Model	***OM***	*OPP*	Org. Process Perform.
O.6.2.1	*Organization*	Life Cycle Model	***OM***	*OPD*	Org. Process Def'n.
O.6.2.1	*Organization*	Life Cycle Model	***OM***	*OPM*	Org. Perform. Man.
O.6.2.2	*Organization*	Infrastructure			
O.6.2.3	*Organization*	Project Portfolio			
O.6.2.4	*Organization*	Human Resource	***OM***	*OT*	Org. Training
O.6.2.5	*Organization*	Quality Man.	***OM***	*PPQA*	Process & Product QA
P.6.3.1	*Project*	Project Planning	***PM***	*PP*	Project Planning
P.6.3.2	*Project*	Project Asses. & C.	***PM***	*PMC*	Project M&C
P.6.3.3	*Project*	Decision Man.	***OM***	*DAR*	Decision Ana.&Resol.
P.6.3.4	*Project*	Risk Management	***PM***	*RSKM*	Risk Management
P.6.3.5	*Project*	Configuration	***OM***	*CM*	Configuration Man.
P.6.3.6	*Project*	Information Man.			
P.6.3.7	*Project*	Measurement	***OM***	*MA*	Meas. & Analysis
T.6.4.1	*Technical*	Stak'hldr. Req. Def'n	***E***	*RD*	Requirements Dev.
T.6.4.2	*Technical*	Req. Analysis	***PM***	*REQM*	Requirements Man.
T.6.4.3	*Technical*	Architectural Design	***E***	*TS*	Technical Solution
T.6.4.4	*Technical*	Implementation			
T.6.4.5	*Technical*	Integration	***E***	*PI*	Product Integration
T.6.4.6	*Technical*	Verification	***E***	*VER*	Verification
T.6.4.7	*Technical*	Transition			
T.6.4.8	*Technical*	Validation	***E***	*VAL*	Validation
T.6.4.9	*Technical*	Operation			
T.6.4.10	*Technical*	Maintenance			
T.6.4.11	*Technical*	Disposal			

When one step further is gone by analyzing these components in separate Project and Organizational dimensions, we see that the components may be presented different constellations, in ISO 15288 and CMMI v.1.3 respectively. Their view on Project and Organizational dimensions differs dramatically. A component, which is taken in the organizational dimension in one framework may be handled in project dimension in the other or vice versa. CMMI v.1.3 seems to handle the processes more in organizational process components, while handling agreement issues in project dimension.

Also, some of the project processes of ISO 15288 seem to be better handled in routine organizational activities rather than temporary endeavors like project wise processes. Hence, the project processes proposed by them do not fully map each other. Besides, they do not comply with the actual project processes in practice. This is somehow normal, because project management approach in practice is fairly newer than the other two lanes; systems engineering and capability modeling. Though, the notional or hypothetic approaches in project management are mature like the other two lanes. For this reason project process is referring PMI PMBOK processes in this work, in where they are well defined in an interdisciplinary way in relation with higher components, like program and project management.

6.6 DESIGNING SOLMAZ-FW

Harmonization of Systems Engineering, Maturity Model and Project Management processes gave the result of SOLMAZ-FW, a novel holistic institutional management process framework, proposed to guide the enterprises, implementers and researchers in the field. The proposed work aims to depict all important dimensions, components, levels and relations of the institutional management. SOLMAZ-FW achieves this aim by harmonizing the necessary processes of interdisciplinary fields; systems engineering, organizational management and program management; with work systems approach. Harmonization here aims more than mapping. Clearing the overlaps, constellation of components in the most strongly related dimension, definition of the components and their interrelations with systems approach are the basic concepts of harmonization.

SOLMAZ-FW has three main dimensions and levels as shown in Figure 58. Three management levels organizing the components (process groups) hierarchically are Senior (Corporate, Executive) Level, Middle (Business) Level and Base (Operational) Level. The dimensions (process families) are Systems Management, Organization Management and Program Management. Systems Management is composed of management of engineering and other technical management issues those may be needed in any industry in order to implement technical means for use. Program Management issue is mainly concerned on project management and coordination of several projects and activities residing within the portfolio of the corporation. The details about dimensions in accordance with levels and components are given in Chapter 6.7.1 to 6.7.3.

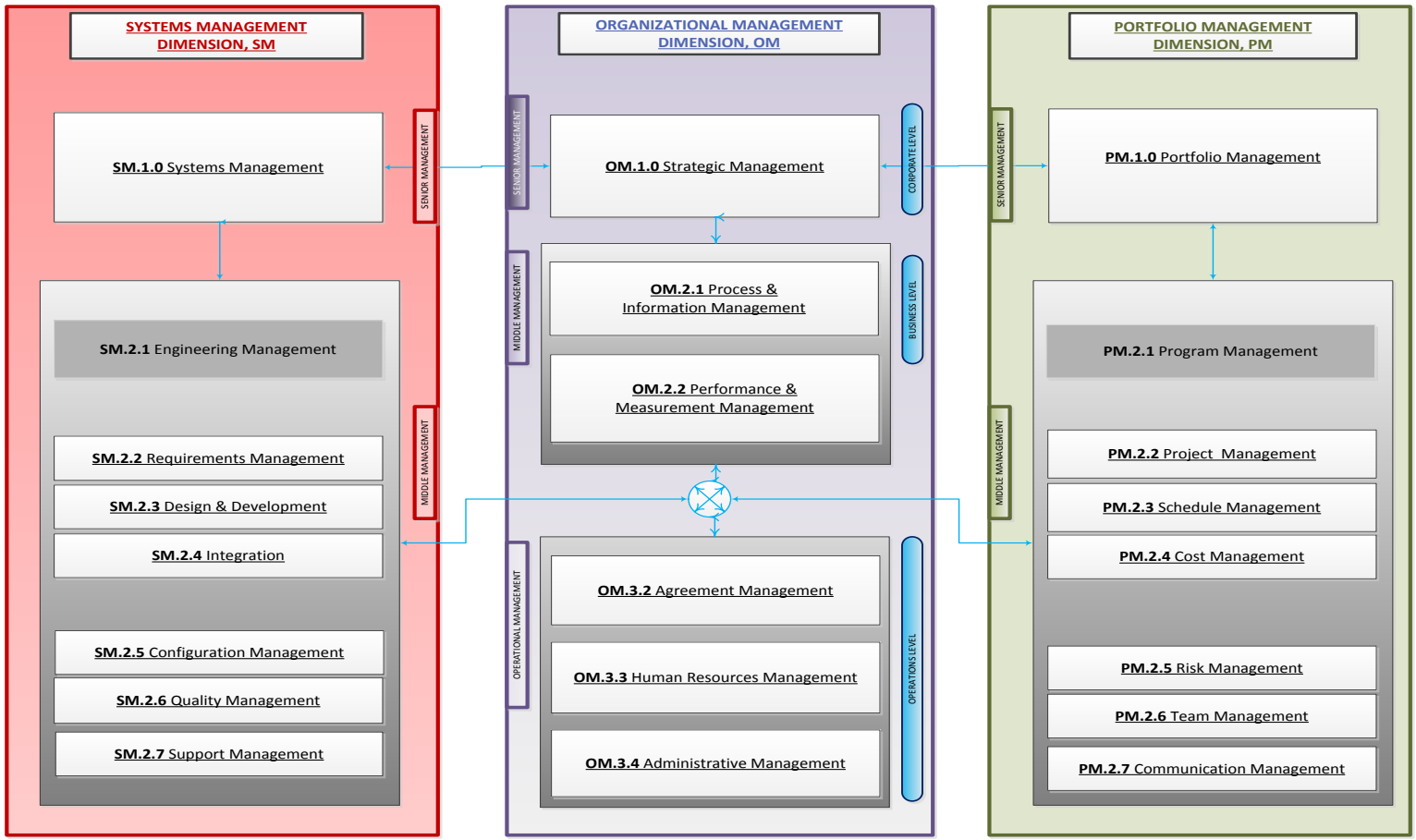

Figure 58 – SOLMAZ-FW

6.7 SOLMAZ-FW DIMENSIONS AND LEVELS

6.7.1 Organizational Management

Organizational Management Dimension will form the vertebra of SOLMAZ-FW. This dimension is important as a backbone for enabling the framework stand straight and relate with other internal sub-systems, those are referred as dimensions in this work. For this reason, this dimension is strongly guided by the specific processes offered by ISO 15288 and CMMI v.1.3. Strategic Management Concepts [29], Enterprise Systems Engineering Concepts [98], [99] from other references are also supporting this dimension effectively in order to relate the framework with external business environment as well.

Organizational Management Dimension forms the base for all process of any dimensions of the framework for an institutional management. By the aid of Organizational Management Dimension, processes in SOLMAZ-FW are able to interact, collaborate and perform results. The 3 levels of management; basic/operational, middle/business and senior/corporate levels; are explicitly seen in this dimension. This dimension is abbreviated by the initial letters of the dimension, as OM. Numeric extensions put after the dimension abbreviation will represent the level and sub-level of the components. Hence, 1.x will represent senior level, 2.x middle and 3.x basic level. 1.x level components of the other dimensions is interacting with OM.1.0 and guiding 2.x level components residing under them. 2.x level components of the other dimensions will mostly be interacting with OM.2.x and highly demanding on the transactional or operational results of OM.3.x.

6.7.1.1 Strategic Management

SOLMAZ-FW starts with OM.1.0 Component of Organizational Management Dimension, which is Strategic Management Process Group. Strategic Management concept is excessively studied in business administration and not so successfully applied in practice. CMMI v.1.3, had mentioned the points of this concept in General Practices. ISO 9001 clearly underlines Mission, Vision and Policy issues, but they reside more on quality issues rather than general pan-corporate issues in practice. The processes of this component clearly help participants of the organization to see not only the target of the corporation but also the several ways to reach there. This visibility dramatically increases the participation of the people. This component also aids as a bridge for the corporation to the external environment and business context. For these reasons, application of Strategic Management Process Group is vital for institutional management.

6.7.1.2 Life Cycle Management

Any process utilized should explicitly and professionally be defined and implemented in a suitable work system of the corporation. There may be several

work systems, serving various processes belonging different departments, in a corporation. For this reason, this definition and implementation work should be performed by the owner of the work systems, but with the strong coordination of the process owners and users. Work System Owner will not only install and sustain the platforms and tools technically; like databases, information systems, enterprise management systems; but also guide, execute and document the information and process management on these work system tools, in coordination with the participants. This group of processes will form the component OM.2.2, Process and Information Management.

The name may be confusing due to the fact of defining a group of processes for process management. In some literature, sometimes this function is related with life cycle management. But in SOLMAZ-FW, Process Management instead of Life Cycle Management is chosen as life cycle today highly reminds software management techniques like agile, spiral etc. Process of managing the whole processes by a unique component is also vital due to excessive number of various processes in several works systems. Process Management today, should also be handled with information management due to the increasing information based results of the processes of today.

One step further of this component is Knowledge Management (KM). For mature and sophisticated corporations, KM processes would also be embedded in this place. OM.2.2 is strongly in coordination with Requirements and Configuration Management components of the Systems Management Dimension, and Content Management component of Program Management dimension.

This view, handling of various levels of processes and information, also supports the 3-leveled structures of Senior - Middle - Basic Level Management and Knowledge - Information - Data duality.

6.7.1.3 Performance and Measurement Management

In many guidelines, the performance management is not defined well. The ones defining performance management had separated it with measurement and analysis processes. This is somehow normal, as performance management is more dedicated to senior level management in organizational management dimension and measurement and analysis seems more suitable for lower levels of management especially for project or engineering processes. Lower level management activities at organizational dimension mostly utilize routine operations those are not measured and analyzed like processes.

In SOLMAZ-FW performance and measurement processes is held together and a new component combining them is formed. The main reason is enabling the measurement of the performance of all processes residing at any level and at any dimension of the corporation. A second supporting factor of such design is explicit showing of the relation between process measurement and performance

measurement. For higher level business performance management, the output of the lower level management's measurements for the projects, process and other activities is needed.

6.7.1.4 Administrative Management

The operational/transactional management level starts with the component OM.3.1, Administrative Management. For the components of this level, they are mostly supported by routine operations and instructions which are strictly in compliance with and bounded by laws and regulations. The administrative management includes the working areas of financial, planting and inventory. Financial field includes budgetary, accounting and book keeping issues. Planting field may include facility management and security issues. At inventory field purchasing and stock issues are generally held. Purchasing is also having strong interactions with OM.3.3 component, Agreement Management. The outputs of these operations are highly demanded by components of SM.2.1 Engineering Management and PM.1.0 Program Management.

6.7.1.5 Human Resources Management

This component aids the sustainability of the human resources of the corporation by aiding to identify, develop skills, plan carrier for the participants and acquire them for the corporation. Mostly this also gives way to knowledge management, which is taken in to account at a higher level management component; Process and Information Management.

6.7.1.6 Agreement Management

In most guides conventional and contractual issues are embedded with project processes. In most, it is almost forgotten. ISO 15288 defines it explicitly, which is much better than embedding it to project processes. But ISO 15288 shows it in an independent dimension solely formed by acquisition and supply. In SOLMAZ-FW, this depiction seems unnecessary. Agreement concept is handled within the Organizational Dimension, strongly interfacing the corporation with its business environment by the aid of laws and regulations.

6.7.2 Systems Management

The special feature of this dimension is the sustainable engineering processes; those collaborate with organizational and programmatic processes, for the resulting systems. These processes are not temporary like the ones in project dimension, nor supportive, founding formative like the ones in organizational dimension.

6.7.2.1 Systems Engineering Management

According to Defense Acquisition University's Systems Engineering Fundamentals, a system is an integrated composite of people, products, and processes to provide a need or objective, and engineering is applying the knowledge of pure sciences during the design, construction and analyze of the objects. From this step, Systems Engineering can be seen as an interdisciplinary management concept using engineering, business administration and management disciplines to transform operational needs into specifications and requirements, to achieve design, development and integration of complex systems. These complex systems do not have to be only technical/engineering systems; they can also be organizational and societal systems. Hence, it has a natural socio-technical perspective.

In SOLMAZ-FW, System Management Dimension is leaded by the component SM.1.0, Systems Engineering Management Process Group. SM.1.0 is the higher level component, which gives the principles of systems engineering management and coordinates the management of the existing systems within the corporation, bridging the Systems Management dimension to the Organizational and Program Management dimensions by relating the engineering efforts to the other components of SOLMAZ-FW.

6.7.2.2 Engineering Management

SM.2.1 component of the Systems Management Dimension is the Engineering Management Processes group. It is the envelope process group for the management of the engineering efforts and applications with effective planning and efficient operations, with the remaining SM.2.x processes.

Actually, evolution of concepts of engineering management, systems engineering and systems management is really one inside the other. Today in literature, they are still interfered. In SOLMAZ-FW, Systems Engineering Management is taken as the higher level management process group of the Systems Management Dimension, bridging engineering processes to other dimensions of SOLMAZ-FW. In Engineering Management component of the framework, sole engineering and technical processes is defined.

6.7.2.3 Requirements / Configuration and Quality Management

In this work, Requirements, Configuration and Quality Management components (SM.2.2, SM.2.5 and SM.2.6) are totally handled within System Engineering Management, due to the technical constraints in carried in their nature. In practice this is many times overlooked. They are many times deprived as temporary endeavors or just bureaucratic paper works and mixed with data, information or data management. The demand on sustainable engineering perspective in these components is necessary for corporate culture, knowledge management and continuous improvement, hence institutionalized management. Important point here

to mention is that SM.2.6 is primarily focused on quality engineering, hence including systems qualification, verification and validation efforts. With this perspective, it is aimed to clear the meaning of quality, increasing the engineering demand and correcting the misunderstanding of quality is just paper work.

6.7.2.4 Design / Development / Integration / Support Management

The components of Design and Development, Integration and Support Management (SM.2.3, 2.4 and 2.7) are under Systems Management Dimension trivially. The only important point to mention on these would be merging of some components. Design and Development is merged due to the fact of today's integrated development environment. They are not strongly isolated phases of a systems engineering life cycle anymore. Many important technical processes are either lacked or just taken as after-sales / customer satisfaction issues in many of the existing guides. They must be handled in systems management dimension. Component SM.2.7, Support Management aims this by harmonizing transition, operation, maintenance, warranty and disposal phases of a system lifecycle.

6.7.2.5 Risk Management

Systems Engineering Standards or Maturity Models also defines Risk Management clearly. SOLMAZ-FW's contribution on Risk Management is not on definition, rather in positioning. Even, risk management is strongly required in technical or engineering activities, in SOLMAZ-FW, Risk Management is solely considered under Portfolio Management Dimension. This is because; Risk Management has more project process nature regarding temporariness and cost. Also any risk for engineering management can still be handled in this Risk Management Component in Portfolio Management Dimension, as the handling of these risks converge on the resulting product or service.

6.7.3 Portfolio Management Dimension

Portfolio Management Dimension of SOLMAZ-FW will contain the process groups to support the corporation activities to align with corporation strategy and business goals, coordinate these activities and balance them with scope, time, cost, risk, team and communication management. SOLMAZ-FW will adopt the perspective of PMBOK for its Portfolio Management Dimension.

6.7.3.1 Portfolio Management

Portfolio Management is the main component this dimension to the others. It aids the alignment of the corporation's work with respect to the Business Goal defined in Strategic Management. Portfolio Management serves the processes executed by senior management for orchestrating the whole activities of the corporation. Portfolios can be comprised of sub-portfolios, programs, projects and other activities such as services or operations. These contents do not have to be strictly interrelated.

Portfolio Management balances the execution of these contents in order to reach business goal alignment.

6.7.3.2 Program Management

Program Management Component of SOLMAZ-FW solves the close coordination of the projects and other activities under portfolio management. The main issues related here is serving a coordinated and common direction and execution of financial management and stakeholders management for the projects and activities in the same programs. Program Management also feedbacks Portfolio Management for the coordination of programs (composed of strongly related projects and activities) with other programs, projects and activities residing in the portfolio of the corporation.

6.7.3.3 Stakeholders Management

Definition and positioning of Human Resources Management, Team Management, Stakeholder Management and Communication Management in existing guides are mentioned but they do differ a lot with respect to each other and are sometimes quite blurry. In SOLMAZ-FW, work systems view is utilized. For this reason, Stakeholder Management Component is formed; regardless participants are internal, external, individual or group.

In SOLMAZ-FW, the human resource and carrier management of the internal participants (individual or group members of the corporation) for a project or program under scope is performed in Stakeholders Management Component, in strong coordination with Project Management and Human Resources Management, OM.3.2 component of the Organizational Management Dimension.

Stakeholders are vital components of project work systems and their participants (individual or group) are natural members of project teams, regardless they are external to the corporation. In SOLMAZ-FW, management of stakeholders external to the corporation is performed within Stakeholder Management component, trivially from the name of the component. This component is one of the most important gateways of the corporation, and needs to be in strong coordination with Program and Project Management. In addition, management of Sub-Contractors, Main Contractors, Pilot Contractors, Suppliers and Acquirers are handled here, as they are the strong stakeholders of the programs and projects a corporation is entitled. For this reason, a strong coordination between this component and OM.3.3 Agreement Management under Organizational Dimension is necessary.

6.7.3.4 Project Management

In correlation with PMBOK for SOLMAZ-FW, Project Management is the direction, execution, monitoring, control and harmonization of the endeavors to apply knowledge, skills, tools, and techniques to activities in order to meet the

requirements of the project result. Project Endeavors are temporary and the project result is a unique product or service. By this way, they strongly differentiate with the Transactional/Operational Level Activities of Organizational Management Dimension, at where the operations and activities have a routine nature for the foundation of the corporation base. With respect to Systems Management Dimension, the processes here have no engineering/technical vision. They do have project vision like content, cost, team, procurement and communication management. To achieve this, they highly utilize the routine organizational operations. They also utilize the outputs of Systems Management Dimension effectively, for creating a unique project result as means of products, services or information forms. Besides, with respect to Project and Program Management an application field perspective is highly demanded for project management in order to have a command of project content, which is formed by project scope and constituents integration. An application field may be which can be engineering, science, information, health, finance or service field for example.

6.7.3.5 Schedule Management

These two components are the trivial components of Portfolio Management Dimension, supporting Portfolio, Program and Project Management Components with their non-technical temporary natures. Schedule Management's processes are trivial from its name, mainly developing a schedule for a project and managing it. The important inputs will come from Systems Management Dimension for estimating the activity durations. Similarly, the schedule constraint of stakeholders (contractors, suppliers, acquirers, etc.) is received from the component PM.2.6, Stakeholders Management. Upon to this point, Schedule Management will order, arrange the activities hence create the project schedule.

6.7.3.6 Cost Management

Cost Management has also almost the same relations with component PM.2.3, Schedule Management to other dimensions and components. It receives inputs from SM Dimension for estimating activity costs and arrangements. Also receives inputs from Stakeholders Management similarly for external cost options.

One important point to mention here is, PM.2.4 processes are at a higher management level (Middle / Business Level Management) than the accounting and budgetary operations performed at the component OM.3.4, Administrative Management. PM.2.4 is in strong coordination with OM.3.4 and utilizes its operations in order to perform its processes. Similarly, PM.2.4 strongly inputs its project cost management outputs to PM.2.1 for financial coordination and management of projects within a program. This relation for financial coordination and management is also valid in between PM.2.4 with PM.1.0, PM.2.1 with PM.1.0.

6.7.3.7 Communication Management

Today, Communication is managed in digital environments by the aid of information and communication technologies utilized in any work system of corporations. The main issue is harmonizing these work systems internal and external to the corporation in order to perform seamless flow of information between participants and stakeholders. The level of security, integrity and casting will sure be regulated by the sponsors of the activities. The forms, approaches and timing of communication are defined in this component. PMBOK defines its Communications Management as a knowledge area which includes the processes required to ensure timely and appropriate generation, collection, distribution, storage, retrieval, and ultimate disposition of project information. SOLMAZ-FW utilizes this definition to some extent. It clearly defines project communication and project documentation processes in separate within this component. Upon to this definition step, these processes are in strong coordination with the components OM2.1, Process and Information Management, OM.3.2 Agreement Management and SM.2.5 Configuration Management. Coordination with OM.2.1 is needed for transforming the lessons learned and knowledge earned in project works into organizational assets. Coordination with OM.3.2 is trivial due to the fact that OM.3.2 borders and envelopes the definitions of stakeholders and their relations. Interaction with SM.2.5 is also vital for correlating the project work and documentation to project or routine technical work package configuration and documentation.

In SOLMAZ-FW, in addition to Documentation Management during project work is totally neglected in all of the existing guides. This neglecting is mostly due to reason that there is a trivial demand for documentation and its management during any project work. It is strongly believed that this clear definition for Documentation Management will both correct, first the misunderstanding about Requirements, Configuration and Quality Management mentioned before, and seconds the organizational data, information and knowledge management. Collecting, Archiving, Creating and Management Project Documentation are done within this component. Hence, Project Assets Library administration performed here is in interaction with Organizational Management Dimension by feed backing Organizational Assets Library handled in OM.2.1.

SOLMAZ-FW, in addition strongly mentioned project documentation and management of this issue in Project Management component. Because, it is seen that this issue is somehow embedded in Configuration Management issue in PMBOK, where this and Requirements Management is not well handled. Also the engineering perspective residing in Quality Management naturally was not visible in PMBOK. In SOLMAZ-FW, these three components (Requirements, Configuration and Quality Management) are handled in Systems Management Dimension, in order to define them explicitly, show their ingenious and inventive features clearly, and correct the misunderstanding them as bureaucratic work.

6.8 SUMMARY

In this models/standards/best practices quagmire, the aim of this thesis is to propose a novel framework for industries, which aims to be not only interdisciplinary and holistic, but also balanced with systems thinking. The first aim, interdisciplinary and holistic view, is achieved by utilizing Systems Engineering, Project Management and Organizational Management processes all together, forming the three dimensioned skeleton for the artifact. The balances is sought to be done by well harmonization and tailoring of the processes. The process families are grouped within each dimension and be shown in three levels of management. The families are highly cohesive and loosely coupled. High cohesion is achieved by adding the definition of relations between processes and families. This will aid the systems thinking view in the artifact. Loose coupling is done by addressing each process in a single process family, hence letting no overlaps. At the end, these steps will bring the comprehensive and compact nature of the artifact as an important novelty.

In this work, CMMI and ISO 15288 had strongly guided Systems and Organization Management dimensions. Whereas, PMBOK had guided Program Management dimension. For higher level organizational management issues Strategic Management Framework [29] and Systems Engineering Body of Knowledge Frameworks [98], [99] are also good sources for tailoring the proposed framework of this study.

This work fills a gap for industry and academy as a real connection for engineering management and project management activities in one model with no overlaps. Common activities and processes of both models are analyzed thoroughly, redundancies are eliminated, differences are highlighted, prioritized and ordered logically based on real life. It is very well known that there is no standardized common-sense set of lessons learned, best practices, neither leading guidelines, nor frameworks for the implementers and researchers to guide them during their work against failures in the related markets. In this work, the motivation is proposing a resolution to this ill-natured problem, by defining a framework for researchers and practitioners in order to aid them for Information Systems Implementation and Adoption, with the mention of all important dimensions and components of Information Systems.

CHAPTER 7

EPILOGUE

7.1 SUMMARY and DISCUSSION

In today's business, the WS Failures are still at high rate. One of the main causes of these failures is the big lack of the implementation of interdisciplinary approaches and systems thinking with holistic views in business. This lack can be redressed with a strong guidance, of which would be suitable by its high usability.

For any WS Activity, corporations should jointly plan for the key organizational, management and technical investments, as they are highly interrelated [29], [92]. This is vital for adapting to the dynamic natures of business concepts, and hence highly critical for enabling business goals. For this reason, each of them should be examined carefully and concurrently. Hence, the success can only be achieved by the collaborative and harmonized execution of the related WS activities, which are dedicated to different practices of engineering, technology, information, systems, portfolio, program, project, or organizational management. For this collaboration and harmonization, senior management should be aware of their organizations', participants' and stakeholders' demands and involvement. Any initiative for WS activities should be based on this awareness with clear reasoning and communication for high benefit to cost ratios. All these activities demand a holistic interdisciplinary systems approach to capture the managerial, organizational, and technical and informational aspects of WS. During WS activities, corporations tend to avoid using guidance, either because there is a lack of corporate culture for guide exploitation, or because the guides are followed only with the intention of assessment and certification in order to catch the market trends. In parallel, users may be either unaware about the existing guides, or may be finding the guides' usability very low and hence their usage inefficient.

All these issues require conforming guidance as solution. Existing guides are mostly field specific, text oriented, lacking entity relations, having unbalanced perspectives and multi views. This disables their usability dramatically. The HWSF has dramatic advantages for fulfilling WS guidance. The entities' definitions and

relations are up-to-date with respect to today's business environments, enabling the support of contemporary concepts like agile, lean and program management. Entities are instanced from both social and technical disciplines enabling interdisciplinary approaches. The dimensions and levels are defined and in accordance the entities are allocated with relations, enabling systems thinking. HWSF is presented in a high level conceptual depiction in a unified view, enabling usability with a holistic view.

The design and evaluation of the HWSF fully complies with the IS Research Design Science Guidelines. In accordance with this guideline, the HWSF is designed as an artifact in the form of a conceptual framework (Guideline 1). The problem relevance is posed in the Chapters 1 to 4 respectively (Guideline 2). The verification methods used in the HWSF Evaluation is presented in detail in this Chapter (Guideline 3). These methods are classified in four main groups of Descriptive Evaluation, Analytical Evaluation, Observational Evaluation and Experimental Evaluation. The novelty of the HWSF work reveals itself by defining and relating the WS entities, allocating them correctly, and enhancing with respect to today's work contexts. These novelties of the HWSF are the concrete Research Contribution (Guideline 4). With these novelties, HWSF aims to revise the WS Perspectives. Research Rigor is effectively performed with the Knowledge Base defined in Chapters 1 to 4 (Guideline 5 vs. Guideline 3). Rigor is achieved by appropriately applying existing foundations and methodologies. In behavioral science, methodologies are typically rooted in data collection and empirical analysis techniques. In design science, computational and mathematical methods are primarily used to evaluate the quality and effectiveness of artifacts; however, empirical techniques may also be employed. These analyses, research and elicitation activities serve as conformance for the assessment of the Design Process as a Search Process (Guideline 6).

7.2 FINAL CONCLUSION

The research design artifact of this work, referred to as the HWSF, is a conceptual framework aiming to guide researchers and practitioners during their WS activities and related pursuits. Interdisciplinary approaches are highly credited and adopted by researching the framework entities thoroughly in these disciplines and kept up-to-date with respect to today's literature and business contexts. Harmonization of these entities within dimensions and levels enabled a systems approach. The HWSF is kept conceptual, possessing visual depictions and high level definitions enabling holistic approach. With these novel features, critical points for WS activities would be elicited in the early phases, hence errors, risks, obstacles, constraints would be cleared, their transition to failures would be eliminated and WS utilization success would be enabled. All these featrues make the HWSF a unique guide for various WS activities and processes performed in different areas (technical, project or organization management) and fields (engineering, information or education). Only with the aid of these novel features, the HWSF served as a strong base for developing SOLMAZ-FW successfully.

7.3 FUTURE WORK

First future work plan is performing SOLMAZ-FW's Experimental Evaluation. The preliminary work of this plan has already started concurrently during the last phases of the HWSF work. Second future work plan is collaborating on Prof. Steven Alter's IS Body of Knowledge with the HWSF and SOLMAZ-FW.

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APPENDICES

APPENDIX - A : QUESTIONARIES

A.1 Survey

This is a survey to analyze the contemporary work systems including business environment, context, models, structures and tools people use today. There is no right or wrong answers to the questions, but the perceptions of the interviewees. Each interviewee's perception will help to draw the big picture on the issue. The results are intended to be used for research purposes only and be exploited in academic papers. The anonymity is acknowledged in academic papers with the permission level of the interviewee. In the questions multiple answers may be selected. Qualitative answers range from 'Very high' to 'Very low' are mapped to a quantitative range of '5' to '1', or '100-80%' to '20-0%', roughly.

1. What is the type of the corporation you work for?

   a) Private b) Public c) University d) Foundation e) Non-Profit Organization

2. What is the area of the corporation you work for?

   a) Engineering b) Service c) IT d) Consultancy e) Finance

3. What is the total number of the Employees working in the corporation you work for?

   a) 1-10 b) 10-100 c) 100-500 d) 500-1000 e) 1000+

4. What is your position in the corporation?

   a) Team Leader b) Manager c) Executive d) Admin. e) Specialist – Engineer - Developer

5. How long have you been working in this corporation?

   a) <1 b) <2 c) <4 d) <8 e) <20 f) more

6. What is the field of your work in this corporation?

   a) Engineering b) IT c) Quality d) Support
   e) Other :

7. How long have you been working in the field you work now?

   a) <1 b) <2 c) <4 d) <8 e) <20 f) more

8. What activities are held in the corporation you work for?

   Enterprise Architecture, Business Process Management, Risk Management,

   Information Management, Software Management, Business Development,

   Quality Management, Portfolio Management, Project Management,

   Program Management, Customer Management, Performance Management,

   Strategic Management, Change Management, Configuration Management,

   Requirements Management, Engineering Management, Systems Engineering

9. What activities are planned to achieve in 1-3 years in the corporation you work for?

   Enterprise Architecture, Business Process Management, Risk Management,

   Information Management, Software Management, Business Development,

   Quality Management, Portfolio Management, Project Management,

   Program Management, Customer Management, Performance Management,

   Strategic Management, Change Management, Configuration Management,

Requirements Management, Engineering Management, Systems Engineering

10. How is the situation (up-to-date, effective and improved) of the activity definitions and implementations in your corporation?

    a) Very high b) High c) Moderate d) Low e) Very low

11. What is the level your knowledge about your work system(s)?

    a) Very high b) High c) Moderate d) Low e) Very low

12. What is the level your knowledge about the guides prepared for your work system(s)?

    a) Very high b) High c) Moderate d) Lowe) Very low

13. What are the important perspectives to analyze your work system(s)?

    a) Technical b) Social c) Interdisciplinary d) NI e) Others

14. How would you define your work system? What entities and relations does it have? On which dimensions it is built up?

15. What do the important dimensions those constitute your work system(s)?

    a) Management b) Organization c) Information

    d) Technology e) NI f) Others

16. What is the importance of *Management* as a dimension you mentioned in a Work System?

    a) Very high b) High c) Moderate d) Low e) Very low

17. What is the importance of *Organization* as a dimension you mentioned in a Work System?

    a) Very high b) High c) Moderate d) Low e) Very low

18. What is the importance of *Information* as a dimension you mentioned in a Work System?

    a) Very high b) High c) Moderate d) Low e) Very low

19. What is the importance of *Technology* as a dimension you mentioned in a Work System?

a) Very high b) High c) Moderate d) Low e) Very low

20. What are the guides followed in the corporation you work for

ISO 9001 IEEE/PMI PMBOK CMMI ISO 15504
PRINCE2 IPMA ISO 27001
ISO 15288 INCOSE SE HB NASA SE HB

SEF of DAU IEEE 1220 ESA ECSS ITIL
COBIT EFQM TOGAF DODAF
Others :

21. According to the guides selected for the corporation you work for, any support is taken?

a) Training, b) Consulting, c) Assessment, d) Tool, e) None

22. Which guides are planned to be followed in up-coming 1-3 years?

ISO 9001 IEEE/PMI PMBOK CMMI ISO 15504

PRINCE2 IPMA ISO 27001 ISO15288

INCOSE SE HB NASA SE HB SEF of DAU

IEEE 1220 ESA ECSS ITIL COBIT

EFQM TOGAF DODAF

Others :

23. What kind of support on these planned one(s) is planned in the corporation you work for?

a) Training, b) Consulting c) Assessment, d) Tool, e) None

24. Which guides are to be assessed /certified (organizational/individual) in the corporation you work for?

ISO 9001 IEEE/PMI PMBOK CMMI ISO 15504

PRINCE2 IPMA ISO 27001

ISO 15288 INCOSE SE HB NASA SE HB

SEF of DAU IEEE 1220 ESA ECSS ITIL

COBIT EFQM TOGAF DODAF

Others :

25. How is the situation (up-to-date, effective and improved) of the activity definitions and implementations in the guides?

a) Very high b) High c) Moderate d) Low e) Very low

26. What is the correlation between the existing activities in the corporation you work for among 1 to 5?

a) Very High b) High c) Moderate d) Weak
e) Very weak

27. How is the definition and information of the Business Goal in the corporation you work for?

a) Very High b) High c) Moderate d) Weak
e) Very weak

28. What is the correlation between Business Goals and the activities of the corporation you work for?

a) Very High b) High c) Moderate d) Weak
e) Very weak

29. What is the correlation between the existing processes and the followed guides?

a) Very High b) High c) Moderate d) Weak
e) Very weak

30. How should the correlation be?

a) Very High b) High c) Moderate d) Weak
e) Very weak

31. How much are the guides followed covered by the activities of the corporation you work for?

a) Very High b) High c) Moderate d) Weak
e) Very weak

32. Usability of the guides followed by the corporation you follow

a) Very High b) High c) Moderate d) Weak
e) Very weak

33. How would you define a good guide for your work system? What specialties should it have to be a guide, to be a good guide?

34. Reason of the strategic decision on following and/or assessment for the guides?

a) Customer Request b) Market Trends c) Management Initiative d) Organizational Culture

d) Others :

35. Benefit / Cost Ratio of following the standard?

a) Very High b) High c) Moderate d) Weak
e) Very weak

36. Participants Adoption

a) Very High b) High c) Moderate d) Weak
e) Very weak

37. Management Commitment

a) Very High b) High c) Moderate d) Weak
e) Very weak

38. Stakeholder Involvement

a) Very High b) High c) Moderate d) Weak
e) Very weak

A.2 Interview

1. What kind of WS applications is performed in your Corporation in the last year?

a. Process Improvement?
b. Technology Adoption?
c. Platform Implementation?
d. Accreditation, Certification?

e. Other, which one(s)?

2. What was the main cause/reason?

    a. Market Demand
    b. Business Model Demand, Stakeholder Request
    c. Management Initiative, Strategic Business Goal
    d. Organizational Need
    e. Participants Application
    f. Other WS Application
    g. Other

3. How was WS Application life cycle achieved?

4. Which approaches are utilized? Any holistic, systems, interdisciplinary, socio-technical approaches used?

5. Any guides utilized? Which one? How?

6. What is management? Levels, components, relations?

7. What is organization? Levels, components, relations?

8. What is technology? Levels, components, relations?

9. What is information? Levels, components, relations?

10. How has the team for WS activities been formed?

11. How has the progress been monitored?

12. How have the conflicts been solved?

13. How well did the communication work?

14. How efficient did you perform trainings?

15. How did you measure the effectiveness?

16. What are the feedback mechanisms you employed?

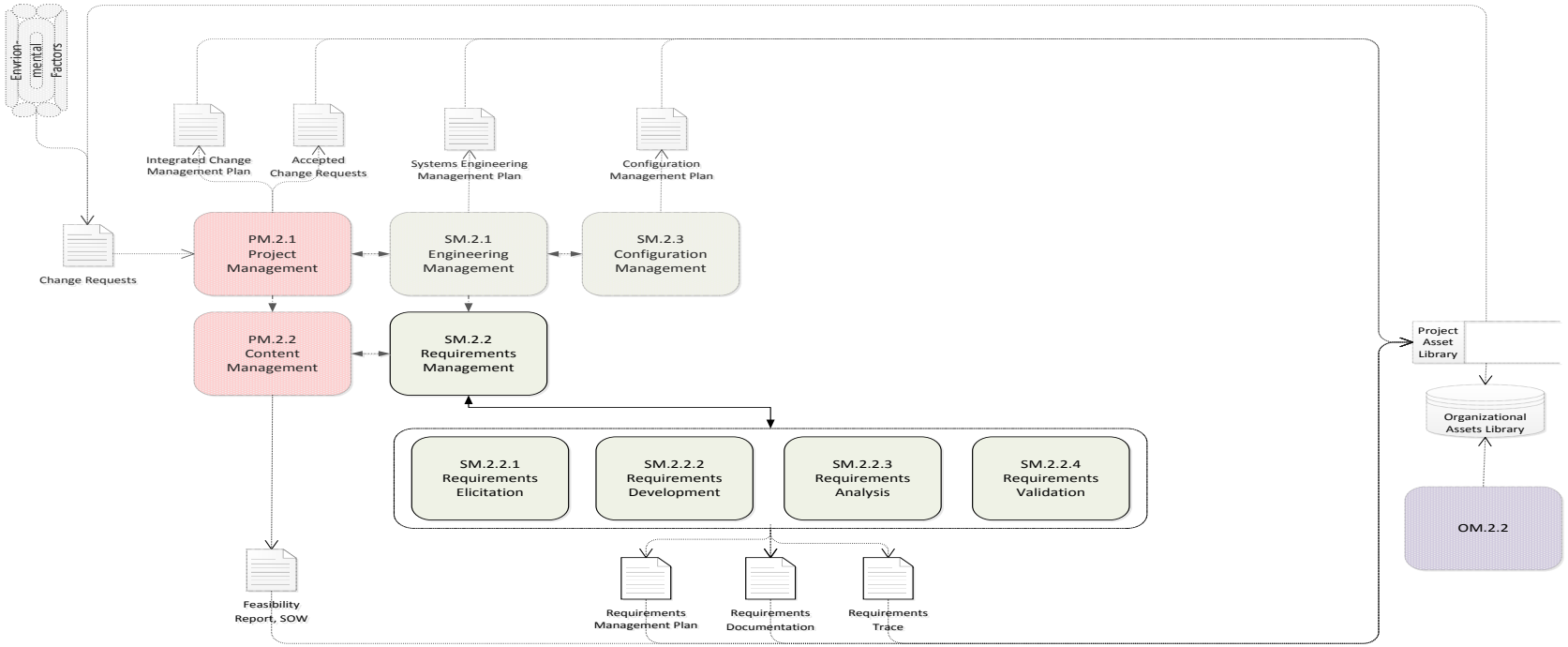
17. How much effort did you spend on discussing lessons learned?

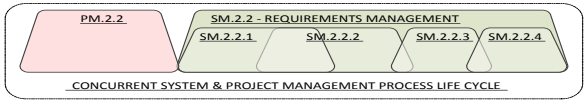
18. What were your motivation sources to enable your employees to adopt the WS?

19. Did you receive any support from academia?

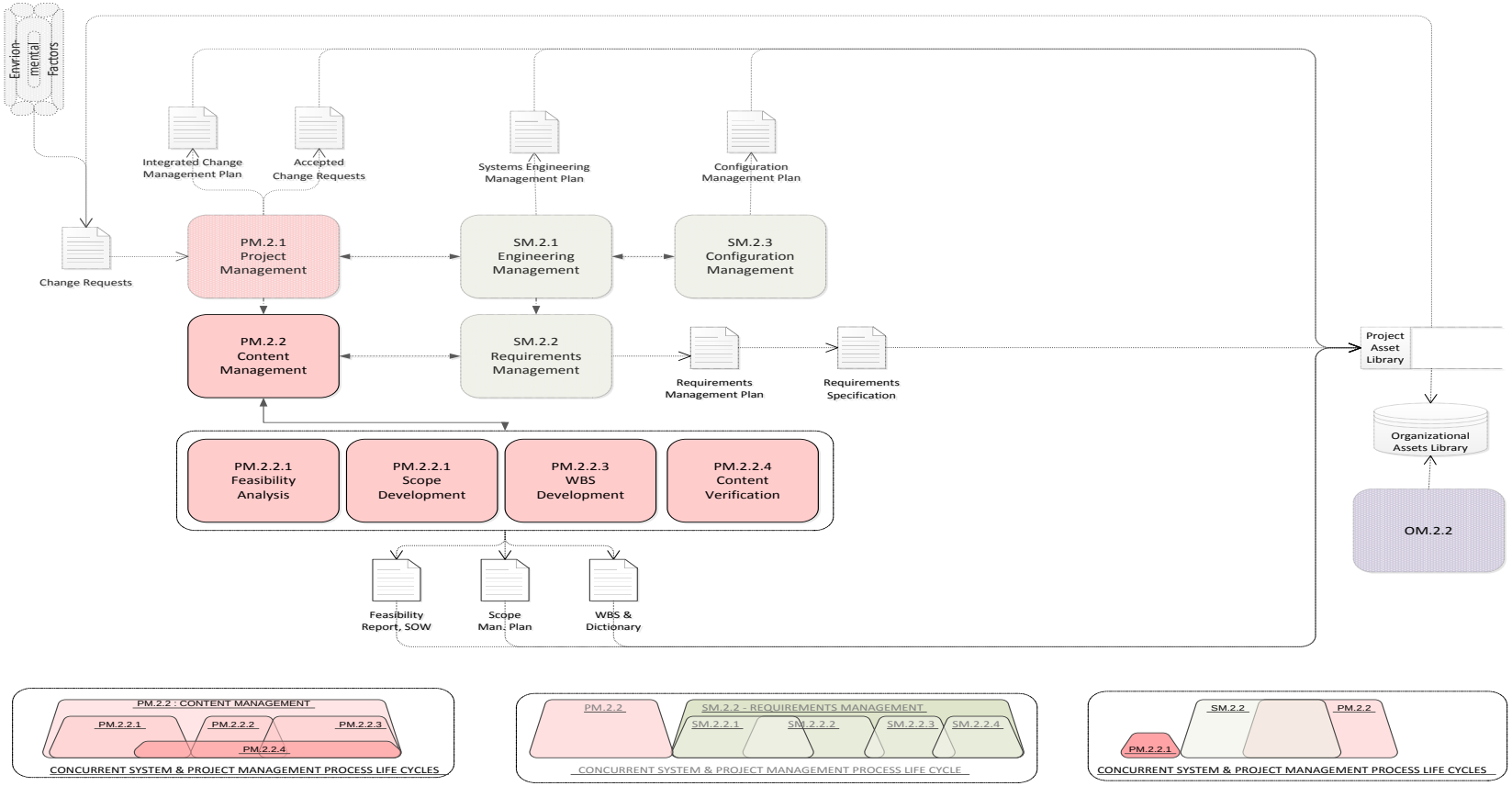
APPENDIX - B : HARMONIZED PROCESSES

B.1 Requirements Management Processes

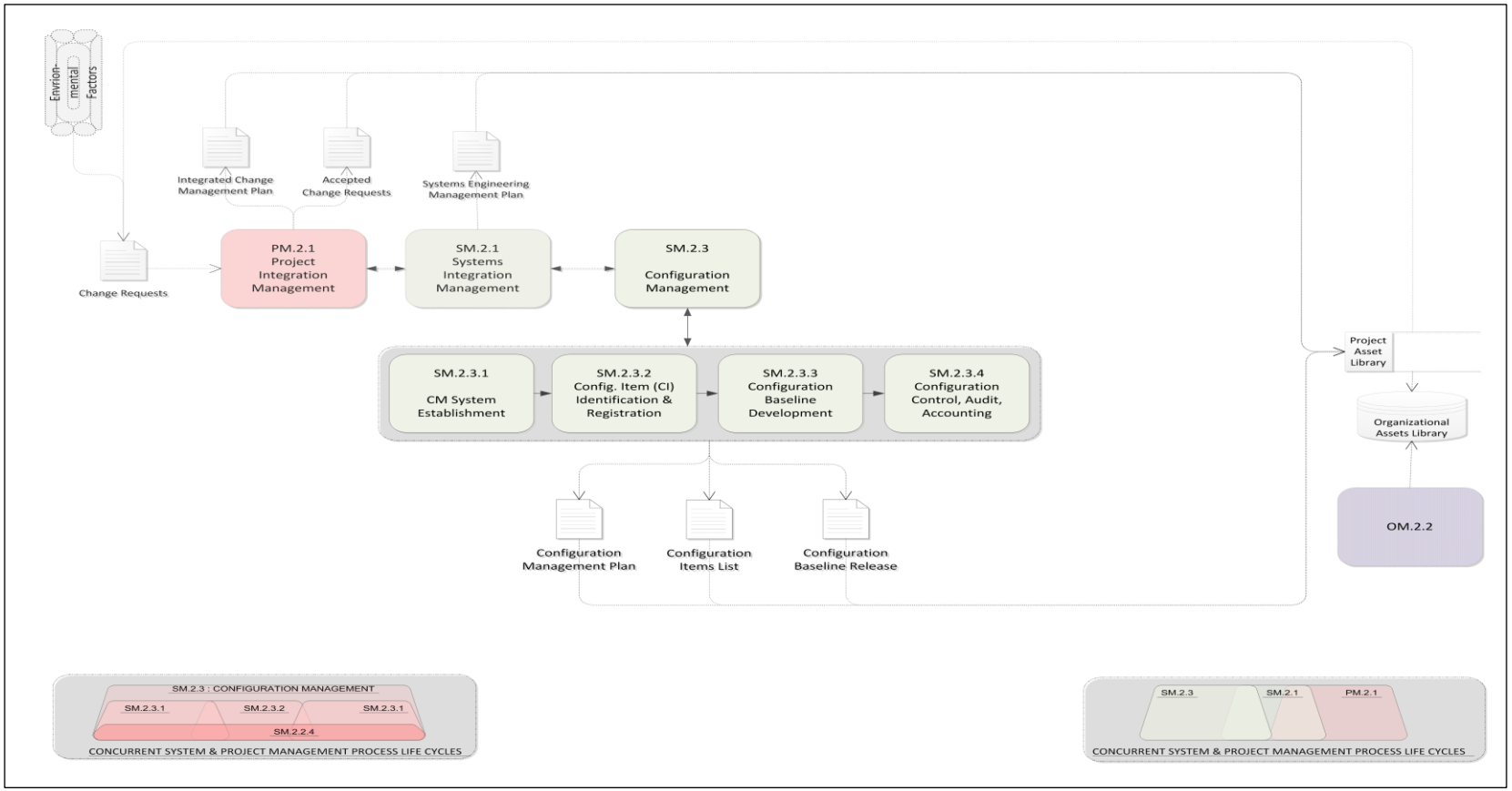




B.2 Configuration Management



B.3 Context Management



APPENDIX - C: THE HWSF DESIGN CHART

The design and evaluation process of the HWSF completely complies with the IS Research Desig Science Guidelines. Due to the nature of conceptual artifacts, the design and evaluation process of the HWSF is highly iterative and recursive, which is also dictated by IS Research Desig Science Guidelines. This iterative and recursive nature is well defined in the design and evaluation chapters with careful references. This appendix is especially developed for the aid of researchers and practitioners, and to depict this iterative and recursive nature of the IS Artifacts' R&D process more graphically. Because, the textual definitions always remind more logical cascaded flows, and cannot make the concurrency within the process flow clear enough.

The main input of the HWSF Design is the Knowledge Foundation. The HWSF Design starts with the aid of this foundation. The foundation contains not only academic but also practice survey. Hence, it includes scientific definitions and contemporary business concepts, on what the HWSF is developed. This foundation is also very critical source for the HWSF Evaluation for setting criteria and methodology. The main input for the HWSF evaluations is the HWSF Design, as after each evaluation and iteration, this design knowledge becomes more refined with respect to the WS context. For this reason, the knowledge foundation is rather a critical supporter than the main input to the HWSF Evaluation.

After each evaluation, the HWSF is not only verified but also iterated when necessary. Besides, the activities in each evaluation process strongly aided and supported other evaluations. For example, Descriptive Evaluation uses the knowledge base effectively for evaluating the HWSF with informed arguments and for scenario creations. Similarly, Analytic Evaluation uses the descriptive evaluation outputs for comparative, static, architecture analyses and optimization. Without these two evaluation methods, observational and experimental evaluations could not be built for the HWSF work. During interviews of the observational evaluation, the analytic evaluations are again done with the experts group. This did not only verify the HWSF, but also the analytic evaluation methodology. Similarly, there had been many concurrencies for reviewing the informed argumentations, scenarios, analysis of the HWSF during observational and experimental evaluations those are surveys, interviews, retrospective and prospective case studies. These concurrencies, in dotted red lines, aided another iteration alternative to the HWSF Design and Evaluation, in addition to the green iteration lines. Both together formed loops with dark blue design input lines, where these loops generated the recursive nature of the HWSF Design and Evaluation, as depicted in Figure 59.

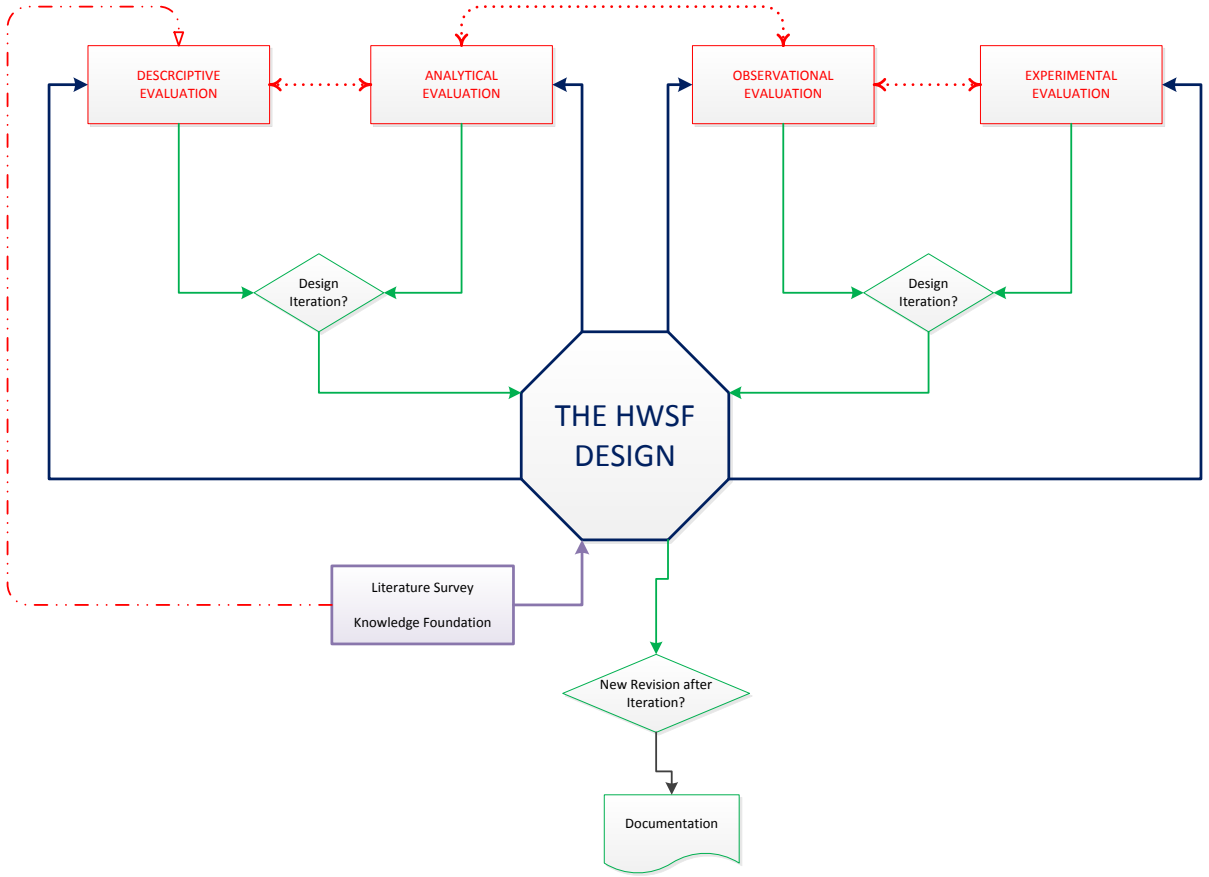


Figure 59 – The HWSF Design Chart

VITA

Egemen Özalp was in Eskişehir on December 20, 1974. He received his B.S. degree in Electrical and Electronics Engineering from the Middle East Technical University in July 1997. He is a Chief Senior Researcher in TÜBİTAK and has been conducting duties like Project Manager, Process Owner, Quality System Manager, Program Management Department Head, ISO 9001:2000 Internal Auditor and CMMI Internal Assesor. His main areas of interest are systems engineering management with holistic interdisciplinary approaches. He is advanced in English as a foreign language.