A Competence Oriented IT Education Reference Model : A Proposal to Process Improvement in IT Education Institutions in Afghanistan

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A dissertation
presented to the Faculty
of Literature and Linguistics
of Bayreuth University
in candidacy for the degree
of Doctor of Philosphy (Dr. phil.)

Dissertation
Zur Erlangung des akademischen Grades eines
Doktors der Philosophie (Dr. phil.)
durch die Sprach- und Literaturwissenschaftliche Fakultät
der Universität Bayreuth

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Zweiter Gutachter: Prof. Dr. Sebastian Bab

April 2025

Abstract

Ministry of Higher Education in Afghanistan is the responsible body for closing the gap between the high job market demands and local IT experts. Knowing the dire need of local IT experts, the ministry approached the problem with establishment of IT education centers and faculties of computer sciences in various Public universities around the country. Several universities are offering bachelor degree programmes in computer sciences as well as vocational training courses through IT centers. The preliminary steps are taken and it's time for those institutions to offer higher degree programmes and to improve their current status.

Process improvement helps organizations save on resource consumption in delivering quality products. Studies have shown that more work can be done if processes within organizations are well-structured and follow a certain order. To address the IT development needs of Afghanistan a functional IT Supply System is required. An IT Supply System would keep the organizations IT needs in check and concentrate on future independence of those organizations in terms of the need for foreign IT experts. IT education is one of the aspects that prepare the local IT workforce to take over the role on running the IT Supply chain themselves. Thus universities as autonomous bodies with their own complex structure are responsible to provide the society with competent IT experts. Therefore, it is important to optimize and improve processes within those educational bodies who are dealing with preparation of the future competent work force.

Improving quality of IT Education service is an optimal goal of every educational institution that offers such a service. A reference model is made using the CMMI for Development model to identify IT Education-related processes and express how to apply process improvement in Computer Science Faculties of the developing countries like Afghanistan where low budget is allocated to quality and process improvement.

The work at hand has evaluated, observed and analyzed the process areas within the Computer Science Faculty of Herat University and has compiled an adaptable version of the CMMI to help improve those specific process areas. The process areas identified in this work are the ones where most of the academic members of the faculties could save time should they be further optimized and improved. Since faculties in public universities around the country have a similar structure, the work at hand can be applied to any and hence is not limited to the Faculty of Computer Science at Herat University.

Die Zusammenfassung

Das Ministerium für Hochschulbildung in Afghanistan ist die zuständige Stelle, um die Lücke zwischen den hohen Anforderungen des Arbeitsmarktes und lokalen IT-Experten zu schließen. Die dringenden Bedarf an lokalen IT-Experten war das Ministerium bewusst, deswegen wurden mehrere IT-Bildunszentren und Informaktifakultäten in verschidenen staatlichen Universitäten eingerichtet. Mehrere Universitäten bieten Bachelor Studiengänge in Informatik und Berufsbildende Studiengänge über ihre Rechenzentren an. Die vorbereitenden Schritte sind unternommen und es ist an der Zeit, dass diese Fakultäten höhere Studiengänge anbieten und ihren aktuellen Status verbessern.
Die Prozessverbesserung hilft Unternehmen, den Ressourcenverbrauch bei der Bereitstellung von Qualitätsprodukten zu senken.Studien haben gezeigt, dass mehr Arbeit geleistet werden kann, wenn Prozesse innerhalb von Organisationen gut strukturiert sind und einer bestimmten Ordnung folgen. Um den IT-Entwicklungsbedarf Afghanistans zu decken, ist ein funktionierendes IT-Versorgungssystem erforderlich. Ein IT-Versorgungssystem würde den IT-Bedarf der Organisationen in Auge halten und sich auf die zukünftige Unabhängigkeit dieser Organisationen in Bezug auf den Bedarf an ausländischen IT-Experten konzentrieren. IT-Ausbildung ist einer der Aspekte, die die lokalen IT-Mitarbeiter darauf vorbereiten um die Rolle des Betriebs der IT-Lieferkette selbst zu übernehmen. Somit sind Universitäten als autonome Organisationen mit einer eigenen komplexen Struktur dafür verantwortlich, der Gesellschaft kompetente IT-Experten zur Verfügung zu stellen. Daher ist es wichtig, Prozesse innerhalb der Bildung Organizationen zu optimieren und zu verbessern, die sich mit der Vorbereitung der zukünftigen kompetenten Arbeitskräfte befassen. Die Verbesserung der Qualität des IT-Bildungsdienstes ist ein optimales Ziel jeder Bildungseinrichtung, die einen solchen Dienst anbietet.Ein Referenzmodell wird unter Verwendung des Ansatzes des CMMI für Entwicklung Model erstellt, um Prozesse im Zusammenhang mit der IT-Ausbildung zu identifizieren und auszudrücken, wie Prozessverbesserungen an Fakultäten für Informatik in Entwicklungsländern wie Afghanistan angewendet werden können, wo ein geringes Budget für Qualitäts- und Prozessverbesserung bereitgestellt wird.
Die vorliegende Arbeit hat die Prozessbereiche innerhalb der Fakultät für Informatik der Universität Herat bewertet, beobachtet und analysiert und eine anpassbare Version des CMMI zusammengestellt, um zur Verbesserung dieser spezifischen Prozessbereiche beizutragen. Die in dieser Arbeit identifizierten Prozessbereiche sind diejenigen, in denen die meisten akademischen Mitglieder der Fakultäten Zeit sparen könnten, sollten sie weiter optimiert und verbessert werden. Da Fakultäten in staatlichen Universitäten im ganzen Land eine ähnliche Struktur haben, kann die vorliegende Arbeit auf alle angewendet werden und ist daher nicht auf die Fakultät für Informatik an der Universität Herat beschränkt.

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Abbreviations

No.	Abbreviation	Complete Form
1	ABM	Afghan Business Machine
2	ACC	Afghan Computer Center
3	ACSA	Afghan Computer Science Association
4	AfgReN	Afghanistan Research Network
5	ANGeL	Afghan Next Generation e-Learning
6	AWCC	Afghan Wireless Communication Company
7	CDMA	Code Division Multiple Access
8	CMMI	Capability Maturity Model Integration
9	CL	Capability Level
10	CPM	Critical Path Method
11	DAAD	German Academic Exchange Service
12	DNUAC	Define-Measure-Analyze-Improve-Control
13	FAA	Federal Aviation Agency
14	GPA	Grade Point Average
15	GSM	Global System for Mobile Communications
16	HE	Higher Education
17	HEI	Higher Education Institution
18	HEMIS	Higher Education Management Information System
19	ICT	Information and Communication Technology
20	IPD-CMM	Integrated Product Development - Capability Maturity Model
21	IPPD	Integrated Product and Process Development
22	ISACA	Information Systems Audit and Control Association
23	ISO	International Organization for Standardization
24	ISO-TC	ISO - Technical Committee
25	IT	Information Technology
26	LAN	Local Area Network
27	ML	Maturity Level
28	MoE	Ministry of Education
29	MoHE	Ministry of Higher Education
30	NATO	North Atlantic Treaty Organisation
31	NOC	Network Operation Center

Continued on next page

Table 1 – *Continued from previous page*

No.	Abbreviation	Complete Form
32	OCL	Object Constraint Language
33	OPD	Organisational Process Definition
34	OPF	Organisational Process Focus
35	OT	Organisational Training
36	PC	Personal Computer
37	PERT	Project Evaluation Review Technique
38	QA	Quality Assurance
39	QAC	Quality Assurance Committee
40	RDM	Requirement Development and Management
41	RINSCA	Regional Informatics Network for South and Central Asia
42	SA-CMM	Software Acquisition Capability Maturity Model
43	SE	Software Engineering
44	SE-CMM	Software Engineering - Capability Maturity Model
45	SECAM	Systems Engineering Capability Assessment Model
46	SECM	Systems Engineering Capability Model
47	SEI	Software Engineering Institute
48	SPICE	Software Process Improvement and Capability dEtermination
49	SQL	Structured Query Language
50	SWOT	Strength Weakness Opportunity Treatment
51	OPF	Organisational Process Focus
52	TEMMPO	Training and Education Maturity Model in Project-Based Organisation
53	TTC	Telecommunication Training Center
54	TU Berlin	Technical University of Berlin
55	UNDP	United Nations Developing Programme
56	UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
57	UNESCO	United Nations Educational, Scientific and Cultural Organization
58	UNFPA	United Nations Population Fund
59	USAID	United States Agency for International Development
60	WAN	Wide Area Network
61	WBS	Work Breakdown Structure

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No.	Abbreviation	Complete Form
62	XML	Extensible Markup Language

Table 1: List of abriviatations used in this Work!

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Dedicated to Maysa Eva and Armin Isaiah, my two navigation stars who have illuminated my journey with their love and laughter.

Acknowledgments

I WOULD LIKE TO EXPRESS my heartfelt gratitude to all those who have supported me throughout this journey. Without their encouragement and contributions, I wouldn't have made it so far.

First and foremost, my never ending gratitude goes to Dr. Nazir Peroz, head of ZiiK at the TU Berlin, who never seized to believe in me und always kept me going forward. His feedback and expertise in the matter of Afghanistan and at the early stages of this work was of trivial help to me.

My sincere gratitude goes to Prof. Dr. Jochen Kubek, whose patience, constant, detailed feedbacks helped me immensely. Yet he gave me the freedom to fly my own flight. He provided his constant support from the first day when we met in Berlin to discuss the very early ideas of this work. Without his support und supervision I would have never completed this work.

I would like to thank Prof. Dr. Sebastian Bab, FH Dortmund, who would always provide ideas and check on my work progress. Our discussions in the margins of the ZiiK Colloquiums at the TU Berlin were always productive.

Dear ZiiK Team members, Andrea Hillenbrand, Daniel Tippmann, Agnieszka Zielinska, Tilman Schieber, Vanessa Hüber, Marius Mailänder, I can never forget your kind support, listening to those long presentations, helping me with the administrative issues at the beginning of my arrival to Berlin and later moving to Bayreuth. You all have left an unforgettable print in my life and for that I will be always thankful.

The International Office at the University of Bayreuth is the very first contact place of every international student. Their support and services make every international newcomer's start at Bayreuth very convenient and comfortable. I would like to thank Amandeep Saini-Egbers and Angela Rösler-Wedlich, Katharina Niechoj and the rest of the team at the International Office of Bayreuth who came along the way and did contribute and help me with settling down in the beautiful City of Bayreuth.

There were various actors from the administration of Herat University, Ministry of Higher Education, DAAD, TU Berlin behind the scenes who made sure I get the right paperwork done at the right time to start this journey in the first place. I am forever thankful to those.

I would like to also thank the colleagues at the universities of Herat, Kandahar, Balkh, Nangarhar and Kabul who took their time and contributed with their ideas, feedback and input through the questionnaires. Without their expert input this work would have been impossible to come together.

A special thanks goes to Dr. Matthias Link, the one friend who always helped me stay focused and kept asking about the progress of this work - our so called coded phrase - ”Let’s talk about the Forbidden Topic”. He would always listen to me patiently. He would share his experience and when things went tough, he would always remind me of the better side of the story.

Without the support of Dr. Abdul Zaher Mohtasebzadah, the deceased Chancellor of Herat University, may his soul rest in Peace, who always believed in the progress of the Faculty of Computer Science, this work wouldn’t have started.

To my loving wife Helene, who always set deadlines along the way and made sure to take care of our lovely kids while I was attempting to meet those deadlines, I am forever thankful to you. You never stopped believing in me and made always sure I stay focused.

The last but not least, I would also like to thank my parents and siblings, my dear friends Khalid Akram and Fahim Barati-Mohring for their unconditional love, support, encouragement and inspiration.

1
Introduction

Information Technology has been one of the most rapidly developing phenomena as it has not only revolutionized our daily life through its mere technological components, but also through its functionality, for instance, the easy way to spread information. Integrating Information Technology in our daily routine to such universal extent has changed our behavior in general, and it has solved and continues to solve numerous problems. Nonetheless, it also brings up many interesting and brain teasing challenges for the scientific society around the world.
Looking at the developing countries, they are not far behind the technological growth. Today, one can see their access to the latest and state-of-the-art technology trends. Many of these countries are following the rapid pace of the development and they have been taking measures to keep up with this progress. However, issues of keeping hold of a state-of-the-art technical equipment does not only add up to the costly bills organizations have to pay, but also in many other aspects such as maintenance, training, timely updates and upgrades, cultural effects and lack of the infrastructure, just to name some of the issues they face.
Afghanistan, as one of the developing countries is no exception. Just in the last 18 years (2002-2020), it was rushed with an avalanche of different technologies. From

companies providing telecommunication services over GSM* and 3G Network, to several ISPs, media stations, software, IT services and solution companies all rushed into the country and surprisingly enough they all work well. Today, more than 89% of the population has at least one mobile phone and around 27% of this statistical figure are registered 3G Internet users (MCIT 2015). In the early years of the establishment of GSM and ISPs, mostly foreign labor forces were working as technicians and maintainers of the technological equipment brought into the country. As time elapses, local processes are mostly run and taken care of by the Afghan young generation itself. A positive point about the ICT development process in the country is that it was looked after and controlled by the Ministry of Information and Communication Technology (MCIT 2015).

Since the emergence of IT, common attempt is to quicken their organizational processes, using the hardware and software IT can offer them. IT Governance (Clarke 2011) is a topic almost each organization around the world either has applied it or is en-route to applying it.

The reemergence of Taliban in August 2021 has slowed down everything and has taken the Afghan development process into a hallow of questions, but what has been so far proven, the ”new” Taliban are more interested into using the Media and Internet and are open to being public as compared to the Taliban in 1990(Ahmadi 2022). In the past decades they have been using social media for reaching people and have seen their impact and effect. In regards to curriculum and study material they have already expressed their opinion on removing certain subjects from the curriculum at universities that are not in harmony with the Islamic and Afghan traditions (Ahmadi 2022), but the ministry of higher education is still determined to stay competitive and competent in comparison to the world. Though so far any official actions are not taken in bringing dramatic changes. As the new Chancellor of Herat University, Prof. Nemani†, has stated in his mission and vision statement on the Website of Herat University, they are still willing to stay up to date. The IT Education system still needs a robust infrastructure and a competence oriented model in IT Education that could help build the roadmap would be helpful.

*Global System for Mobile Communications

†Herat University Website https:hu.edu.af [Last accessed: 06.05.2023 15:54]

The MoHE in Afghanistan is responsible to educate and train the workforce properly. It took an initiative based on a strategic plan to establish computer science faculties in the country to train and prepare the young generation in this new field.

It is a requirement for the MoHE to build an IT Supply System (Peroz 2009a). An IT Supply System is a complete set of items including IT Policy, IT Infrastructure, Demand-Oriented IT Training and Creating Organizational Management Structure (Peroz 2009a). All these parts are interdependent. They should all be considered properly as each of them serves as a pillar to a functional IT Supply System (Peroz 2009a). Such an IT Supply system could meet organizational demands and provide quality services to the organization.

IT Education being one of the pillars to the IT Supply System (Peroz 2009a) takes up a lot of resources. In countries like Afghanistan the following three types of trainings should be put in focus: Basic Training, Training for Technicians and Academic Education (Peroz 2009a).

A very common understanding of IT Governance is to improve organizational processes through straightening computer software processes; therefore, all employees need to get a basic knowledge of how to work with computers and the probable customized software systems of that organization. Continuous basic training programs beside their daily normal jobs must be offered to all employees to give them the right skills and competence to work with the IT systems firmly.

As all IT systems need proper maintenance and need some experts to look after them, training programs must be devised to address their need and reduce the dependency on human resources when importing software or hardware systems. Hence training for technicians as well as bachelor degree and associate degree programs at universities should consider this fact and arrange their study programs in a way that could address this need.

A number of faculties and IT Centers have been established around the country to address the need for having well-prepared IT experts from basic levels to advanced academic levels. Therefore, focus is put on the improvement of the quality of IT Education being offered at higher education institutions and IT centers on the country level. Schwalbe proposes, product quality is the core process of every project with three main constraints i.e. the scope, time and cost (Schwalbe 2013). According to

her, Quality means "Conformance to requirements and fitness for use" (Schwalbe 2013). As she interprets it, quality refers to a product that is built or designed according to the requirements and it is ready to be used the way it was defined in the first place (Schwalbe 2013). According to Schwalbe quality management is consisted of three main processes, planning quality management, performing quality assurance and controlling quality. (Schwalbe 2013):315

Schwalbe (Schwalbe 2013) points out that if an organization wants to keep the quality of their products up, it should always remember to keep the quality control aspect as an ongoing process. This should be run and checked as the product development ages forward.

For institutions that offer IT Education, quality of service still remains a priority. IT trends keep updating fast. New technologies come out every day and that requires new skills. Integrating new aspects of IT requires constant change in the institution's curriculum. People involved in the IT Education have to keep updating everything and react quickly to new changes.

There is a long line of models and methods that are concerned with quality improvement process. CMMI (Capability Maturity Model Integration) being one of those models is of specific interest to this study. Models such as CMMI that can help with the continued need for process improvement within organizations.

Afghanistan is no exception as compared to many other developing nations if we want to evaluate the arrival of Information Technology (IT) in the country. It was overwhelmed with the avalanche of different IT systems (Peroz 2009a). With no mobile phones at all and only 32,500 telephone land lines in Kabul in 2001 (Peroz 2009a). Now almost 89 percent (MCIT 2015) of the population have access to at least one communication medium (MCIT 2015). As people get more dependent on technology, the need for IT experts rises. Government organizations are slowly moving towards implementing IT Governance, which again increases the demand for experts in the field (MoHE 2016a).

Approximately 200,000 students finish high school thinking to pursue their studies with higher education at universities (Aturupane et al. 2013; CSO 2014). Approximately 50,000 of this number get admitted in different fields of study around the country, with the rest remaining behind the university gates due to several factors

where insufficient seating possibilities at the government universities is used as the main reason by those involved(Aturupane et al. 2013; CSO 2014).

Looking at the statistics of Faculties of Computer Science at Herat University as well as Nangarhar University; they show the fact that students interest in getting enrolled at Computer Science discipline increases as the government is putting pressure to prepare the right amount of work force for the future of the country. (Mohmand 2014; Sharifi 2014)

Government organizations are interested in implementing IT governance within their structures, and the young generation is willing to learn IT; hence the Higher Education Ministry puts emphasize on offering IT Education.
Today, there are eight universities around the country offering studies in IT, namely Kabul, Kabul-Polytechnic, Kabul-Education, Herat, Nangarhar, Balkh, Kandahar and Khost public universities. Five of them are equipped with the state of the art IT Centers (Peroz 2009a; Aturupane et al. 2013). The infrastructure for IT Education is almost prepared. Young high school graduates have the option to pursue their studies at higher levels at the universities, obtaining a Bachelor degree at the end of 4 years of successful participation in the IT program.
There are three main issues to deal with:

- The growing number of students who are interested in pursuing their studies in IT
- The fast industry updates found in technologies, which require time, and job trainings.
- Quality of IT Education & services offered to students.

These three points highlight the need for a framework that supports IT education institutions to keep up with the rapid growth of technological advancements. There are evident signs that show the country has given Information Technology and its use in the country's administration system a high interest. Several initiatives are trying to fill the gap between the lack of IT experts and the fast (paced forward) movement of IT industry. Afghanistan can achieve this vision only with introducing a nationwide IT education system. Education is the basis for training the right experts

to bring up this vision. A complete proposal to achieving a standard nationwide IT Education system was already put forward.(Mohmand 2010)

1.1 Aims of the Study

The study at hand is a reflection of understanding the current situation of IT Education in Afghan's state run universities, their interest and approach to contributing to the overall market demand in Afghanistan. The author's past experience working as a faculty member at computer science faculty of Herat University, which is a state run university, his and his colleagues struggles dealing with the administrative and academic activities on the one hand, fast progress of the field of IT on the other hand as well as the pressing demand and expectation of the ministries as main decision makers on improving quality in every aspect of the IT education were the moving factor to conducting and compiling this study.

The study focuses on Computer Science Faculty of Herat University for obvious reasons as the author being a faculty member and having access to the required resources and his personal experience has given him the possibility to understand the nature of the organization under the study better. However, the final findings is not limited to this one particular entity and is adaptable and applicable to every faculty of computer science around the country that offer possibilities of IT Education. The contribution of fellow researchers and IT experts in Afghanistan's universities, who will stay through out this work anonymous for obvious reasons such as data privacy regulations and their personal wish to stay anonymous, has helped to identify the common struggling points and helped drawing a concrete proposal to focus on process improvement in the related faculties. Thus the study at hand could be also adopted to each single entity that offer IT Education in any higher education institution around Afghanistan.

The work at hand follows the qualitative methodologies and using semi-structured questionnaire have collected participants opinion through pre-coded as well as open to explain questions. The goal of this survey was to collect as much different opinions as possible to build up a clear picture of the current situation and to find the points that would need focus to be improved further. Quality being a relative con-

cept is an issue that is always discussed through out the higher education ministry, their strategic plan, conferences and meetings and the search to find ways for achieving quality standards is always encouraged. Therefore, keeping this interest of the ministry of Higher Education in mind, it is argued if one wants to produce quality results, one needs to change the current way of handling processes by improving, introducing alternatives and reducing the execution life cycles of processes, when needed. To achieve process improvement one needs to understand processes properly, identify the redundant steps, reduce them when possible or merge them. In the current day as information travels between nodes at the speed of light, the old legacy methods are not sufficient.

To achieve improved quality goals, it is essential to understand the nature of our organization and what it is capable of. This work focuses on the faculty level as an organizational unit of the university which then again belong to the ministry of higher education. The study introduces the organizational units to give a clear picture of the current situation of a government educational institution that deals with IT and the structure of the organization.

The goal of this work is to identify the key processes that run at computer science faculty and to define mechanisms that could support those processes. It also aims at introducing process improvement possibilities using accepted international best practices, yet adoptable to the nature of the organization at the study. Therefore, the final target is to introduce key points to the process areas that need high attention for improvement. To identify the key points for improvement in the organizational level, the CMMI (Capability Maturity Model Integration) is used as a main reference point to draw a proposal on how to achieve those improvement goals. CMMI as a process improvement framework is used to define the path for each process area that needs improvement, by defining and considering the needed documents, measure and best practices.

1.2 Research Questions & Hypotheses

As for every research work that is carried out, research question is the core for conducting them. (Tracy 2013; Boeije 2010) In fact every research done and worked up

on has started with a basic idea to answer some sort of a question. As it may seem and sound scary to many young researchers at the beginning of their work, it is just as simple as questioning your idea, situation and target. A research could branch out and get out of control, thus the need to have a question, keeps the researcher focused on the main work.

However, when it comes to qualitative research, the questions are normally starting with the words ”how”, ”which” or ”what” (Boeije 2010). It is common to start with very broad questions and then narrow down your question as your research work progresses over time (Tracy 2013; Boeije 2010).
Research questions shape one's work and helps the researcher not to loose track of their main objective and don't get distracted by other shiny research aspects that would come along the way. (Tracy 2013; Jesson et al. 2012; Boeije 2010) For the current work at hand, the author has gone through several small questions until the focus is put on the main question. The following is a list of questions that have been worked with and tried to put answers for them along the way.

- What is Afghanistan's current state in relevance to Information Technology?
- What is the country's mission and vision in promoting IT in the government organizations?
- How does the country manages its accessibility to reliable IT infrastructure?
- Which initiatives on the government level are taken to promote use of computer based systems in the government sector?
- Which government institutions will it be focused on?
- What is the meaning of quality for state-run educational institutions?
- How can known quality improvement models contribute to the quality improvement initiative of government educational institutions?
- Which quality improvement models exist that could help those institutions?

A combined general main question is then formulated as: How can a known quality improvement reference model such as CMMI contribute to the quality improve-

ment initiative of educational institutions in countries like Afghanistan with limited budget allocation policies and interest towards quality improvement initiatives?

Thus with this question in mind, the author needed to go through the anatomy of CMMI Product Suite's models, understand them and justify its process improvement approaches that can be adapted to the situation and conditions of countries like Afghanistan.

Every research work formulates around a hypothesis. As Neumann explains it, a "hypothesis is a proposition to test or a tentative statement that two variables are causally related." (Neuman 2012) It is also safe to say within a hypothesis one puts an informed guess on how a certain target in real world works where in apposed to a research question it bears a neutral form of statement. Every hypothesis should have at least two variables and show a casual or cause-effect relationship between them. The writing style would be a prediction or an expected future outcome. It should have a connection to the research questions and above all the hypothesis stays falsifiable. (Neuman 2012)

Considering the research questions and the aforementioned points, the author has formulated his hypothesis as following: A competence oriented reference model based on CMMI Reference Model identifies all IT Education-related processes, be it organizational or educational, and expresses how to apply process improvement in developing countries like Afghanistan where lack of enough budget allocation often overlooks education quality and thus such a reference model can contribute to quality improvement in IT education.

The key variables for this analysis are CMMI and IT-Education; the relationship between the two is quality improvement. It will contribute to IT education process improvement in such countries like Afghanistan.

The aim is to understand and clearly find out processes that relate to IT Education and categorize and pair them to different process areas defined in CMMI. This classification will suggest process areas and can be put into the right levels to reach the final optimized level for IT Education. Models like CMMI, when customized to the needs, requirements and socio-economic restriction of countries like Afghanistan, can contribute to the quality improvement and can convince the organizational leadership to invest in quality improvement.

The work will also consider preparing an adoption of the CMMI model for the case in study. That would be to formulate a clear framework for each process area and that can be used to apply on IT Education. The reference model should be able to guide process improvement within any institution that is offering IT Education in Afghanistan. Organizations with low interest in investing in quality improvement initiatives due to availability of no or lower budget for such initiatives often need more than just some quantitative probable outcome results.

In such scenarios another encouraging factor could be presentation of a ready to apply framework. Once the organization has access to such customized reference model, and manages to apply it on a pilot project, with the driven results from application on the pilot project, then convincing the leadership gets easier. On one hand they have a ready working model that is tested and shows them results and on the other hand the model is tailored and customized to the actual situation.
In order to identify the right processes as well as to make sure that all the possible processes are identified, the author has approached his colleagues and fellow researchers around Afghanistan's different state-run universities that has an active IT education facility with semi-structured questionnaires. The core foundation of this work and findings are based on the answers provided by those experts. Their opinions and input through those questionnaires have helped structure, categorize and then pair those identified IT Education processes to their equivalent CMMI processes.
The target study institution is selected to be Herat University's Faculty of Computer Science. The reason being simple, the author has graduated from there, was partly also involved in the establishment process of the faculty and then have worked there.

1.3 Roadmap of the study at hand

Offering quality services or products to customers is every organization's optimum goal. On the one hand, reaching such a goal extensively relies on well controlled process execution practices. On the other hand, organizations can save a lot of time, costs and energy of their employees and thus maximize their profit margin, if the organizational processes are well-arranged and well-organized.
The CMMI Product Suite offers a variety of best practices used to identify process

areas within organizations. The models in this product suite identify both and the relevant process areas. The point missing in CMMI Product Suite in general is how-to apply it to different organization structures. The application of this model is a necessary initiative to find out ways to formulate an answer to the missing how to question. CMMI has already solved the problem of what to be improved. Another big challenge for every how to seeker of CMMI Product Suite is the diversity of organizations in terms of size, nature, culture and etc.

Universities have their own complex structure. This level of organizational complexity requires a thorough understanding of their political, symbolic, structural and human resource frames and that is why they are often found as autonomous bodies working all on their own (Duarte and Martins 2011; 2014; Schwalbe 2013). Universities' autonomy is not applicable to every culture as universities in countries like Afghanistan depend on a central body, i.e. the MoHE, that governs and controls everything within a university. A subset of this complex structure is faculties that categorize and offer certain fields of study (MoHE 2015a).

In the Afghan administration system, a faculty is an organizational unit within a university that has to meet specific requirements, such as certain number of departments, lecturers with certain degrees or qualifications and other teaching resources. Department is the smallest organizational unit within a faculty that is responsible for organizing courses, manage students' credit selection and their progress through out a semester as well as the whole course of study program. Its members being the lecturers are tasked to teach, take exam and conduct research. That is why often department names are selected after a field of study or research.

Computer Science Faculties in Afghan Universities are in charge of offering IT Education (Peroz 2009b) to the young generation and thus contribute with their services in promoting the IT Governance around the country. They are training the required workforce with certain skills. On the other hand, the fast pace of technological updates around the world affects the education bodies, and that urges education institutions and especially IT Education Institutions to keep up to date with the technological changes.

The Faculty of Computer Science at Herat University has four departments currently (2020), with 15 faculty members. Security issues and several other ongoing

troubles in the country have reduced the number of lecturers as compared to 2015. The faculty has announced new recruitment positions and the hiring process is running as of the time of writing this section. The faculty lacks class rooms and administration offices, thus every semester the faculty administration is left with a huge room management challenge, which is taken care of using old classical methods. Despite the huge available research range, currently, conducting research is not at the core focus of this institution as the faculty's high priority goal is to complete its workforce and improve its teaching services. More details are provided in the introduction of the setup of the case study, Chapter 2 and Chapter 4 - Section 4.3.

That is why knowing all the processes and process areas within an institution such as Computer Science Faculty that offers IT Education is as essential as keeping up with the technological advancements. The aim is to understand and clearly find out processes that relate to IT Education and categorize them according to different process areas defined in CMMI. This classification proposes process areas that can be put into the right levels to reach the final optimized level for IT Education.
The work also aims at preparing an adaption of the CMMI model that consider the culture and terms of the organization in study. The goal is to have something in hand that is easily adaptable in the organization in focus by formulating a clear framework for each process area. The reference model should be able to cover process improvement within any institution that is offering IT Education.

1.4 Structure of the Dissertation

The study at hand investigates the process improvement possibilities in IT Education in Afghanistan using known process improvement models such as CMMI. Process improvement to achieve quality results and offering quality education is part of the strategic policy of the Ministry of Higher Education in the country. The target organization is the Computer Science Faculty of Herat University. The state of this organizational unit that offer IT Education in terms of organizational structure is similar to other computer science faculties of public universities around the country. The thesis is divided into eight chapters and several supporting materials are included as appendices.

Chapter 1 serves as the introductory chapter explaining the motivations of the author in lights of the problem statement and quality improvement interests of the Ministry of Higher Education. The aims of the study, with its research questions and hypothesis are introduced in this chapter. Furthermore the structure of this thesis is outlined.

Chapter 2 reflects the background information of the study at hand. In this chapter the education system in Afghanistan is introduced. The organizational structures in Afghanistan are explained and the structure at Computer Science Faculty is depicted so as to understand how actions take form in the organization. The top-down management model is explained and a picture on how the education system works, is given. The history of IT development is of special interest to this study since the aim is to introduce process improvement within IT Education institutions in order to improve quality of service. This chapter mainly serves readers to gain an insight about the education system and its history in Afghanistan.

Chapter 3 is dedicated to the literature review and counting out methods, models and tools that deal with the quality and improvement of quality. Here the readers get to learn about various tools and will be prepared to know the CMMI, which turned into the main focus of the study at hand later.

Chapter 4 is dedicated to the methodology, research design and data collection approach used for the study at hand. In this chapter the qualitative methods used for the compilation of the work at hand are explained. The data collection is done through semi-structured pre-coded and open question online surveys, the participants of which were mostly lecturers from the organization at the core of the study — Computer Science Faculty of Herat University - and lecturers from other peer faculties around the country, such as Balkh, Kabul, Kandahar and Nangarhar universities. Their contribution of survey participants, opinion and explanations are analyzed which clears the path towards the final outcome of the study in the next chapter.

Chapter 5 is an analysis to the data collection that were collected through questionnaires. In this chapter a detailed analysis to the questions is provided and the answers that are collected are categorized based on similarity of the topics and put together accordingly. The analysis of the answers are sometimes illustrated with charts to have a quick glance at the results.

Chapter 6 analyzes the process areas that are identified with the help of the survey and explains the need for the improvement and how those process improvement levels at the faculty of computer science could be achieved. The issues discussed in this chapter lay the foundation to building up a small-scale CMMI model that is customized to the requirements, nature and context of computer science faculty, in the following chapter.

Chapter 7 The findings and results refelected in the chapters 5 & 6 are used as the basis for deriving a small-scale CMMI. Chapter 7 is a derivative form driven off of the original CMMI model that is customized to the context of Computer Science Faculty to help boost up process improvement. The identified Process areas within the Faculty of Computer Science are paired to the CMMI Model's Process areas and hence the CMMI vocabulary is then adjusted accordingly.

Chapter 8 is the final and closing chapter of this thesis. This chapter presents a summary of the whole analysis and concludes the need for having such a proposal at hand. The contribution of this study, challenges faced, shortages and open points for further investigations are reflected in this chapter. Final thoughts and future visions are ending this chapter.

2
IT Education in Afghanistan

Chapter 2 introduces IT Education in Afghanistan. In this chapter educational situation of the country with focus on its IT perspectives is presented. It is key to the study at hand to understand how the management runs in Afghanistan. In the first section, a brief history of Afghanistan with more focus on history of Education is put forward. The following sections describe the Education, Information Technology and its infrastructure as well as Ministry of Higher Education and its subbranches and universities. Afterwards, Herat University and its organizational structure with the aim to prepare readers for the research setup is introduced.

2.1 Afghanistan-Facts and Figures

The geographical location of Afghanistan makes it a landlocked country in South Asia. Afghanistan has a joint border with Iran in the West; Pakistan in the East and South; Tajikistan, Uzbekistan and Turkmenistan in the North and a small length of joint border with China in the North-East.
Afghanistan is a mountainous country and its geolocation characterizes it with a dry climate. Hindu Kusch mountains start in the northeast of the country and go down

towards the west. This makes the country mountainous in the north and eastern part whereas plain deserts cover the west and southern part of the country. The geolocation of the country thus brings snowy cold winters and extreme hot and dry summers (NOAA 2008). The winter temperature could vary from -15 degree Celsius in the northern and central provinces to 5 degrees Celsius in the southern and eastern provinces in the winter. Rain falls are mostly limited to the later winter and spring season. Due to the bad infrastructure rain fall in spring often brings in heavy flooding, destroying many agriculture forms and killing live stock.
According to the (World Bank 2019), Afghanistan had a GDP of 18.79 billion with 0.137 % growth in 2019 as compared to the year before (World Bank 2019). More than 85% of the rural population depend on agriculture and horticulture in Afghanistan (World Bank 2019); this requires the country to invest more on irrigation, water supply and providing the market support. Bad security has always affected the economy of the country, and as per the report of the World Bank in 2019 (World Bank 2019), adverse weather conditions as well as crop diseases decreased agriculture production. However, the government and the World Bank have taken initiatives to boost up the economy in 2019. Afghanistan has a lot of beautiful resorts; should the security be established in the country, tourism through out the year could contribute highly to the general growth of the economy. Untouched ski resorts in Badakhshan Province could draw a lot of winter sport enthusiasts and professional athletes .

2.2 Education and its History in Afghanistan

Through out the history, Afghanistan has gone through severe political and ideological changes. Different reigns and kingdoms mostly targeted restoration of peace and power and thus much of energy and many resources were used to achieve those goals. Education was either given less priority or in certain cases limited to children of the elite and royal family members (Ghobar 1973). However, the traditional education, where children were taught to read and write in mosques and homes existed simultaneously and unofficially and this system still exists.
The official foundation of the current education System, was introduced between 1867 to 1878, more specifically during the second reign of King Amir Sher Ali Khan

(Kamgar 2008). Amir Sher Ali Khan wanted to institutionalize the education system and his biggest achievement was the establishment of one civil and one military school. Thus, he earned the title of the founder of the new era of Education in Afghanistan (Kamgar 2008). The administration employees of the education system was limited to a principal/headmaster, local and international teachers, general observers and stock keeper (Kamgar 2008).

Amir Abdul Rahman Khan didn't put up too much effort in promoting and supporting education during his 22 years of reign between 1880 to 1901 (Kamgar 2008). However, his son Amir Habibullah Khan (Kamgar 2008), tried to compensate his father's negligence towards education between 1901-1919. His contribution to the promotion of education in addition to improving the already established civil and a military schools, promoting them to high schools, further number of junior-high schools were also established. Availability of the so called "modern" (Kamgar 2008) education was only limited to Kabul, the capital of the country, whereas in the rest of the provinces the traditional — mosque and home based — education continued. King Amanollah Khan's reign (1919-1929) started with Afghanistan's independence from the British Empire and thus provided Afghanistan the opportunity to hold academic ties with several other countries around the world. He managed to promote the establishment of schools and education system outside the capital and so the establishment of schools in other provinces were also given attention. The 5-4-3 (i.e. five years primary, four years higher secondary and three years secondary) schooling system was introduced during this time (Kamgar 2008). The era of this king allowed French, German and English/American teachers to work at certain high-schools in the capital city of Kabul and girls education was highly promoted as well. However, after King Amanollah Khan was overthrown by his rival Habibullah Kalkani in 1929, the new king closed down all international schools and banned girls education immediately.

King Mohammad Nadershah (1929-1933) was Chief of Army during the kingdom of King Amanollah Khan overthrew Habibullah Khan and took over the power (Kamgar 2008). He made primary education for all citizens in the country mandatory. He focused on the promotion of education, and provided facilities to the young generation for studying abroad (Ghobar 1973). People in Afghanistan have always

tried their best to get educated and using their private resources sent their children abroad, as per records of Ghobar (1979); approximately 1,000 students were studying abroad despite all the poor economical and educational systems status between 1929 and 1933(Ghobar 1973).

After the assassination of King Mohammad Nadershah, his son Mohammad Zahershah took over the power in 1933. He was in power for 40 years until he was overthrown by a coup in 1973 and stayed in exile until his return to the country in 2002 (Times 2014), when he was entitled as the "Father of Nation", the title he kept until his death in July 2007 (Times 2014). Free education was one of the services this king offered. During this period, the number of schools increased, however, this increase could not meet students' demand as the Ministry of Education failed to provide text books and other teaching materials to those schools. Some even believed quality of education was overlooked during this period as the Ministry of Education was not able to control activities of all schools. A number of universities were also established during King Zahershah's reign. Scholarships were given to students to study abroad and international professors were hired to teach at Kabul University and many schools around the country (Kamgar 2008).

After a successful coup, Dawood Khan (1973-1978) took over the power and gave an end to the monarchism in Afghanistan. His contribution to education was more or less the same as of his cousin King Zahershah, though during his reign many schools were upgraded and a huge amount of the Education Ministry's budget was spent for the establishment and completion of schools. During these years one fundamental change that was practiced for a short period was the categorization of Natural Sciences and Social Sciences for the senior students in high-schools (Kamgar 2008). The idea was to have students focus either on social sciences or natural science subjects, to be able to follow up their specializations in the coming up university years.

After the assassination of Dawood Khan in 1978, the Communism regime took the power and ruled in Afghanistan for almost 14 years (Kamgar 2008). At the very beginning of their reign the education seemed to proceed normally, but after a few months, the ruling party started applying their hostile policies. Mostly pupils were forced to spend time attending ceremonies rather than learning about different subjects. Pupils were imprisoned under different names and those who had a political

opinion were killed, including teachers. Religious studies were taken out of the education system and instead, political subjects and the introduction to communism were included. The ruling party of this time, changed the schooling system from 12 to 10 years, however, in the later years it was restored back to 12 years of schooling (Kamgar 2008). It was during the reign of this party that the Soviet Union invaded Afghanistan, thus the gap between people and government increased, many people joined the anti-Russian resistance, and called themselves Mojahedin(Kamgar 2008).

When the Communist Party took over the power in 1978, around 700 Afghan students were studying at different universities in the former Soviet Union; however, this number was increased to 4.000 by the next year (Kamgar 2008). In 1984 the government of Afghanistan and the former Soviet Union of Russia signed a contract. As a result 2.000 children between the ages of 7 and 9 were sent to the Soviet Union every year for attending schools there. With the main aim to learn about Communism (Kamgar 2008). During this period of time students who were party members were elevated to higher classes automatically. Good professors who were not part of the party, were either killed or had to flee the country. The following subjects were integrated into the study programme of school between grade 7 to 12: Introduction to Political Sciences, Social and Economical Structure of Society, Socialism and its Victories in the World, Class and Class Wars, Imperialism or the Colonialism System, Labors' Revolutionary Unions, the History of Russian Federation's Communist Party, Communism - the Best Phase of Socialism, Government and Revolution, The Fair War of "Socialist Block" vs. the Unfair War of the "West Block", The History of Khalq (People) Democratic Party of Afghanistan, The Afghan-Russian Friendship History (Kamgar 2008). University and Teachers Training Center's students had to take the following mandatory courses being taught by Russian professors that were translated by Tajik or Afghan translators: Scientific Socialism, Historical Materialism, Dialectic Materialism, History of Revolutionary Unions, The New History of Afghanistan from 1919 to 1978 (Kamgar 2008). The last subject is being taken as a course by students even today at universities. For some fields of study it is still mandatory to take, whereas some fields have left it optional for their students. As the Russian invasion forced many people to flee Afghanistan, mostly to neighboring countries Iran and Pakistan, the Mojahedin started building up schools for

Afghan migrants. The Afghan Mojahedin founded around 500 schools, mostly primary, outside Afghanistan and some 50.000 pupils were studying in those schools (Kamgar 2008). Several countries, organizations and NGOs contributed to the education of Afghan Migrant refugees through out the time, when Mojahedin were fighting against the Russian invasion(Kamgar 2008).

The Soviet Union's army left Afghanistan in February 1989, with the Communist Regime still in power; the fight of Mojahedin against the regime continued until 1992 (Kamgar 2008). However, Afghanistan enjoyed only six months of peace as the Mojahedin leaders did not come to an agreement on sharing the power. Thus, the country went into another civil war. This civil war was the end to all hope, stability, peace, infrastructure and education. As the Mojahedin leaders, who once fought against the Soviet Army unitedly, were busy fighting each other around the country, busy killing each other and destroying all human norms. A group of Islamic fundamentalist political movement, calling themselves the Taliban, were forming in Pakistan. They took over the power in 1996 and announced their government as an Islamic Emirate. Their education policy was promoting Islamic studies; less attention was paid to natural sciences and mathematics at school during this period. They banned girls from schools and applied their fundamentalist view of life. They ruled over two-thirds of the country until October 2001, when the US led attacks liberated Afghanistan from Taliban regime and the Afghan groups agreed on a deal in Bonn, Germany to have an interim government in Afghanistan which was then led by Hamed Karzai.

The Interim government of Karzai led to a transitional period, followed by the first Afghan elections. With the support of the international society, the new elected government paid a lot of attention to education and worked towards the improvement of primary, secondary and higher education in the country.

In August 2021, the Taliban took over the power once again. Though, till to the point of this writing, they haven't made any statements to their education policies so far, they are stated to remove subjects from the curriculum that does not comply with the Afghan and the Islamic norms. No specific names for the subjects were given(Ahmadi 2022).

2.3 The current Configuration of the Education System

The recent constitution of Afghanistan demands the state to provide free education up to Bachelor degree level to all citizens of the country (Constitution 2004). Articles §43 to §47 of the Constitution emphasize on the role of the state in providing and facilitating free education up to a Bachelor degree at state-run institutions. This facilitation has been one of the several factors in boosting up the growth of literacy rate in the country since 2002 (Naomi 2015; USAID 2016). As of World Banks data source in 2018 the Adult (age group 25-64 years) literacy rate is 30.5 per cent. *

Education in Afghanistan is primarily divided into two sections: school education and university education. The schooling system is further divided into primary education (6 years), lower secondary education (3 years) and higher secondary education (3 years)(EP-Nuffic 2015). The K-12 system in Afghanistan trains a child with the primary education and prepares him/her to enter university for higher education. After successful completion of primary and lower secondary (9^{th} grade) pupils have the option to continue with ordinary higher secondary education or join schools that offer "Vocational Education" (EP-Nuffic 2015). The vocational education consists of three to five years; three years to complete a high school certification (also known as Baccalaureate) and attend the normal *Kankur*† exam or two more years to study in a technical vocational institute. Technical vocational institutes are regulated by the Ministry of Education with the goal to prepare youths for the job market in the country as well as the region (Education 2014).

The transition from school to higher education is regulated by a General Entrance Examination called *Kankur*. This is basically a test covering the majority of topics from the last 3 years of higher secondary education (EP-Nuffic 2015). This exam is a national exam held once a year in different zones of the country, supervised and regulated by a Kankur Committee at the Ministry of Higher Education with a close collaboration of the Ministry of Education. The exam is composed of four main sections, i.e. Mathematics, Natural Sciences, Social Sciences and Languages. The following factors play a major role in the selection process of a pupil as well as his/her

*World Bank Data: https://databank.worldbank.org/DA2_artyom-ashigov/id/cc8b8bb6 [Last accessed: 12.Oct.2024 13:04]

†Concours: French origin, meaning a public contest or competition (Collins 2014)

success to enter a university program; namely the pupil's choice of study, number of available seats at the pupil's chosen institute of higher education and final marks of the Kankur exam. Same factors stand for a pupil's rejection in being admitted in a higher education institute.

As for those pupils who decide to study at a technical vocational school and follow their studies further in a technical vocational institute, they are given a chance to participate a customized Kankur exam designed based on their field of study. Thus, after succeeding in this special exam, they are admitted to the 3rd semester of their major subject at universities in the end of which they will obtain a Bachelor degree. In general, this group of students who studied two years (four semesters) at a technical vocational institute, have the chance to pursue a university degree program in their own field of study. As a result, they should add up one more year. This extra year is put into account as a regulation for moving from a technical vocational institute into a university since the study curricula of the Technical Vocational Institutes and Universities do not match. During this extra one year students have to cover up for the missing credit points and subjects and prepare themselves for stepping into the university courses.

Today, the Home- or Mosque based education, the so called (traditional education), is still practiced in rural areas of the country. The target of this system is mostly to learn reading and writing by learning the Alphabet and then moving on to learning the Holy Koran. Afterwards a number of books from poets that are close to mysticism are studied. The modern education, the foundation of which was put by Amer Sher Ali Khan in 1868 has a fixed face today. The schooling system is divided into three levels i.e. primary, lower secondary, upper secondary or high school. The total duration is 12 years. Afterwards a university degree can be achieved, mainly Bachelor Degree, that consists of four years of higher education. Pharmaceutical and Medical studies show an exception in duration as they last five and seven years consecutively. Private schools and government schools are in charge of offering basic education, whereas private and government universities are responsible to offer higher education.

2.3.1 Administration and Tasks of the Ministry of Education

The Ministry of Education (MoE) is in charge of administering primary education related activities all over Afghanistan. Like every other government institution in Afghanistan, this ministry also follows a top-down centralized management style. Every decision made, every law and regulation derived has to be declared by the ministry. The ministry has gone through remarkable changes and achievements since 2002, as this was the beginning of the new era not just for this ministry but for the whole country.

The ministry's initiatives have eased access to education for all children which has led to a high number of enrollments. In 2001, almost 1 million pupils were enrolled all over the country with almost no girls, whereas in 2013 this number increased to 9 million with 39% of it being girls (UNESCO 2014). The Ministry of Education's effort in increasing the number of school teachers continues and UNESCO's 2015 Education for All Review Report indicates that as of 2013 around 187,000 teachers were appointed. (UNESCO 2014). This number continues growing, while the ministry has also undertaken procedures to improve the qualifications of teachers through several teacher training programs. As of 2013, the number of higher secondary education (EP-Nuffic 2015) has reached 266,000 pupils (UNESCO 2014). This number was expected to reach 320,000 in 2015 (UNESCO 2014), but as of the time of writing this section no official sources were found to confirm whether this milestone was reached or not.

The Provincial Directorates of the Ministry are responsible for carrying out orders and supervise activities of schools. They are located in the central city of each province where they have their own sub-branches in each district. Every activity of schools is regulated, mandated and supervised and has to be reported to the ministry following this hierarchical order. For example, at rural school, the graduating reports of pupils' marks (i.e. in the last year) are sent in forms of printed books — signed and stamped by the headmaster and principle of the school — to the sub-branch which is then sent to the main Provincial Directorate. Then it is forwarded to the responsible section at the Ministry of Education in Kabul. One copy of the book is kept at each level for future references. At each node, the documents are signed and stamped to

prevent any possible forgery of data. This example applies to almost every other government institution in the country. All this flow of information is formed as hard-copy printed documents and report books and stored at archive rooms at each node a long the way.

As of August 2021 the country witnesses another new Government taking over the Political power in the country - the second reign of the Taliban. The new government of Taliban so far seems to be willing to participate and being present in the social media and hence have shown an open approach to presence in media and media conferences. In general, the new government's policies with regard to education and higher education in particular are not yet specified. The banning of several subjects and topics is expected on grounds of the dominance of the Islamic ideology of the Taliban (Ahmadi 2022). The unclear future of Afghan universities becomes obvious upon visiting websites, such as Herat and Kabul University, whose latest updates date back to 2020 or early 2021 when the old government was still in power (HU 2015d); (MoHE 2016c); (KU 2020). Only the homepage of Afghanistan's Ministry of Higher Education contains words by the new Higher Education Minister, Haqqani, addressing the educational community with the aim of establishing a quality higher education system in Afghanistan(MoHE 2016c).

For now, the development of Afghanistan's higher education seems at a standstill; hence, new models and developments could be considered in the process of reevaluating the educational system.

In Herat, in particular, a reduction of academic, research and teaching freedom has been imposed by censorship on academic library resources in addition to the Taliban's gender segregation policy (Ahmadi 2022). It remains to be seen what the future holds for Afghanistan. At least in early 2022 universities opened again. It is yet unclear, for instance, if educational options will open again for female students. Regarding closed schools for girls Hashimi, who is the external relations and donor representative of the Taliban government said "We don't say they will be closed forever". It seems that urban areas are more open to education of females than rural areas (Gannon 2022). In addition, brain drain and the lack of foreign international aid has harmed higher education in Afghanistan Ahmadi (2022).

The reality so far is that the Taliban have adhered to the Organizational Structure

that was established so far and have appointed their own people in the key positions. There is no sign of bringing any structural changes in the core of the system, except taking the female work force off this structure and banning female students from education.

2.3.2 Administration and Tasks of the Ministry of Higher Education

The Ministry of Higher Education (MoHE) is responsible for the administration and realizations of all undergraduate, graduate and post-graduate studies in Afghanistan. Some of the educational services offered by this ministry and its sub-branches around the country also fall under the free education mandate of the Constitution of Afghanistan (Constitution 2004). However, like every new institution in Afghanistan it took a gradual life span until turning into a fully functional ministry.
Higher Education in Afghanistan was introduced with the establishment of a Medical Faculty in Kabul in 1932 (MoHE 2014b). That is the first time the country was introduced to the concept of Higher Education studies. The Ministry of Education was put in charge to take care of the administrative and legalization of the newly established Medical Faculty with the supervision of a Turkish Professor and eight lecturers due to the lack of medical professors in the country (MoHE 2014b).
In the year 1977 the ruling government at that time - Dawood Khan 1973-1978 - , introduced the Ministry of Higher Education and it was put in charge of the mobilization, realization, management and operation of higher education institutions in the country. Moreover a concrete list of goals was set to be achieved and realized by the ministry. Since its establishment, the Ministry of Higher Education has gone through different reforms. One of the major changes worth to mention was the act of 1994 (MoHE 2014b).
This act was to identify and separate the institutions that would offer their participants degree programs or non degree programs. As a result, the responsibility, control and management of all institutions that would offer degree programs were given to the Ministry of Higher Education whereas institutions with non-degree programs were transferred to the Ministry of Education. Therefore, the management of 43 Vocational and Technical Institutions back then belonging to the Ministry of Higher Education was handed over to the Ministry of Education whereas all the Teacher

Training Centers that were offering Bachelor degrees to their participants and were managed by the Ministry of Education was handed over to the Ministry of Higher Education (MoHE 2014b).

2.3.3 Organization and Statistics of MoHE

The following figure - 2.1 - is an abstract image of the management arrangements within the Ministry of Higher Education. It illustrates the hierarchy of the ministry and its sub-branches* (universities) in various provinces around the country. A more detailed representation of one organization i.e. Herat University is given in section 2.4. The universities' organizational structure is almost similar to that of the ministry, as it is often argued that a state-run university is the provincial representation of the ministry. However, this statement has no official basis and thus gives no freedom of action to the universities. They still have to follow every rule, regulation and guideline set by the Ministry of Higher Education. The central top-down management system governs and is in effect in all forms and functions.

In such organizational structures the amount of effort that is put in keeping this top-down approach system in place is very high. Every decision, be it an administrative task or a financial proposal, has to go to the minister for getting a processing order. Afterwards the responsible branch starts processing it and must go back to the minister for getting an execution order. However, one of the few changes in the working approach in the last 20 years was to categorize the tasks, hence, the executive orders can be issued by the relevant Deputy Ministers. This change has reduced the steps by one level.

University is an educational organization with at least six faculties where 30% of the faculty members have a PhD degree or an equivalent terminal rank of "Pohandoy ⇔ Assistant Professor", whereas a higher education institution is an educational institution with at least one Faculty and at least 15% of the faculty members should have a master degree or an equivalent terminal rank of "Pohanmal ⇔ Senior Lecturer" (MoHE 2015a). Based on the official statistics published on the website of the Ministry of Higher Education in 2016 (MoHE 2016a), there are 24 state-run universities

*In Afghan administration and management terminology, universities are often referred to as 'sub-branches' or mini-ministry to separate its academic role as in research and teaching from its administrative role. This form is often used in spoken communication only.

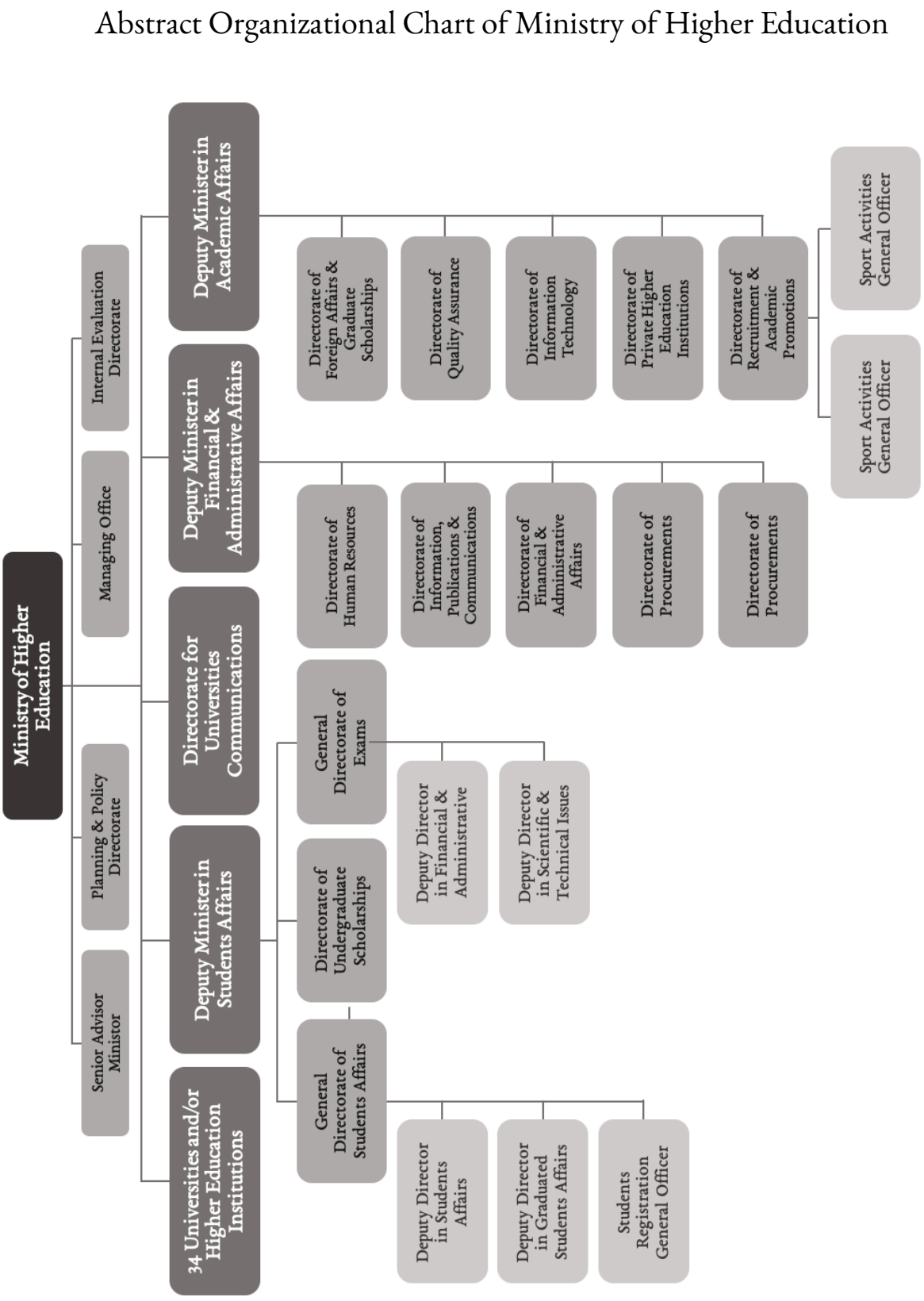

Figure 2.1: An abstract organizational layout of the MoHE based on the update of 2016 (MoHE 2016b)

and 12 higher education institutions (MoHE 2016a) that are established around the country.

A total of 184,674 students are studying at these institutions and 22,16 % of this number are female. The total number of lecturers working at these institutions are 5.472 that leaves us with a ratio of 1:33 professor to students (MoHE 2016a). There are certain plans being followed and executed by MoHE to bring this ratio down to 1:20. Though with the new decree of the President (No 74 Date 02.09.2015) limiting recruitment of lecturers to Master and above degrees only, did slow down this process at least for certain fields of study such as Computer Science. However, the decree was declared void by the President after a couple of years later, after seeing the actual challenges on the ground.

Since the MoHE was facing trouble providing services to the increasing number of higher education applicants, the government passed a law where establishment of private higher education institutions are allowed too. However, these private institutions are still regulated through the MoHE. Ministry of Higher Education keeps the right to control quality and administrative procedures and this ministry will be also the issuing body for certificates. This makes all private higher education institutions accountable to the Ministry of Higher Education.

At the moment there is a total of 128* private universities and higher education institutions certified for activity in the country. As of 2016 (MoHE 2016a), a total number of 139,663 students were enrolled in these private educational institutions. Female students make up 31,721 of this total which is again around 22,71% (MoHE 2016a). However, the number of female students attending either private or government higher education institutions is always concentrated in bigger cities and provinces such as Herat, Balkh, Kabul and etc. These numbers decrease drastically looking at statistics from southern provinces of the country. Table 2.1 shows number of students attending universities differentiated by public or private.

*Appendix (B) shows a higher number of private education institutions and a lower number of government higher education institutions/universities. The difference might be the irregular update process of the pages on MoHE Website. https://www.mohe.gov.af/index.php/en/government-educational-institutions and https://www.mohe.gov.af/en/private-educational-institutions [Last Accessed: 28.01.2017, 14:57]

MoHE Statistics at a Glance - 2015

Item	Number	Students
Public Universities/HE Institutions	36	184,674
Private Universities/HE Institutions	128	139,663
Total (Public+Private)	164	324.337

Table 2.1: Total number of students engaged in higher education studies in Afghanistan(MoHE 2016a)

2.4 Herat University

With over 1.7 million (CSO 2012) inhabitants, Herat Province is one of the five largest provinces of the country located in the west region of Afghanistan. The capital city of this province is named Herat City with an estimated total of 436,300 (CSO 2012) inhabitants. The city hosts one of the oldest and biggest universities of Afghanistan, that is Herat University. Herat Province connects to Turkmenistan in the north and Iran on the west side. Thus makes the province one of the major economic hubs for the country. Records show that Customs revenue was 221.10 million US$ in 2013 (Leslie 2015). Badghis, Ghor and Farah are the neighboring provinces of Herat Province internally. Thus, the higher education institutions in those provinces are a filial of Herat University.

Herat University was founded in 1988 with one faculty offering studies in Humanity and Literature (HU 2015d). Since the establishment the university has gone through different expansions and development phases. Currently, it has two campus sites in the city. The main campus, which is located in the north of the city, hosts most of the students and faculties while the second campus hosts faculties of Education and Social Sciences. It is located closer to the center of the city.
According to its strategic plan, published on the website of the university, the university tries to reach three basic goals, namely Discovery, Learning and Engagement (HU 2015d). The achievement of these goals requires much work and time. However, certain factors, such as the increasing number of university applicants who are introduced through Kankur Exam (See section 2.3 for details on Kankur), limited budget, limitation in economic autonomy due to restricted government financial procedures and many more, slow down the realization process of these goals. (HU 2015d)

2.4.1 Herat University Organization and Statistics

Herat University hosts a total of 14,897 (HU 2015d) students from all around Afghanistan. This university offers its students 71 study majors which are arranged within 16 faculties (HU 2015d). Table 2.3 lists all the existing faculties and the major of studies they offer. Until 2018 this university offered only undergraduate study programme that are taught by a total of 430 lecturers with different educational backgrounds (HU 2015d). As of 2018 a master degree program in the fields of Human Sciences and Economy studies were also introduced.

Herat University pictured in an organization Chart

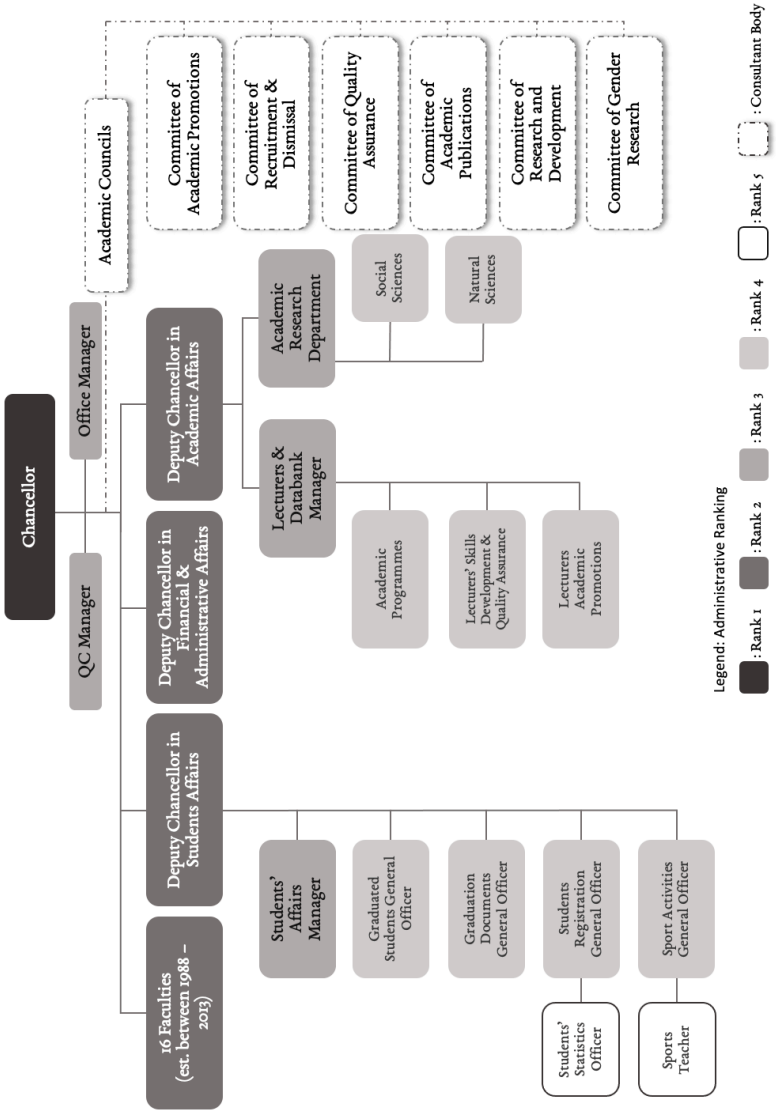

Figure 2.2: An abstract organizational layout of Herat University(HU 2015d)

Figure 2.2 is the organization chart that represents the organizational structure of all government and private universities with very minor differences. Those differ-

ences mostly depend on the number of faculties, students and operation units. The top-down managerial approach to run the universities apply to all without any exception. As exhibited in the organization chart of Herat University, several layers distinguished by the Administrative Ranking system (Rank 1 to Rank 6 in example of Herat University) exists. The hierarchy is always kept and often the superior and inferior organizational behavior among all employees can be noticed.

Figure 2.3 shows a detailed organization chart illustrating the office of Deputy Chancellor in the Financial and Administrative Affairs at Herat University, where employees with the administrative ranking 2 to 6 are currently working.

Herat University's Financial & Administrative Affairs' organization Chart

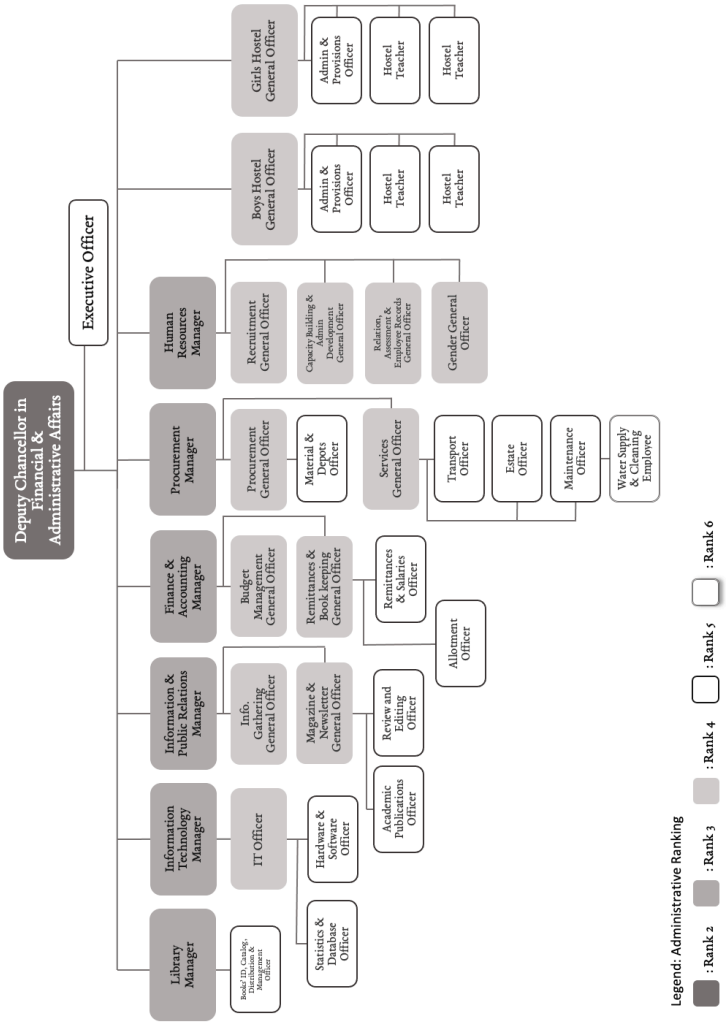

Figure 2.3: The Organizational layout of Deputy Chancellor's Office in Financial & Administrative Affairs (HU 2015d)

Since the structure of the office of Deputy Chancellor in Financial and Administrative Affairs required more space, thus the organization chart of this chancellor's

office has been drawn on a separate page here. The main goal for these details is to point out the difference of the academic ranking that is explained next, and the administrative ranking system.

There is an academic ranking system next to the administrative ranking system as well. Every academic member of the university follows a certain terminal academic ranking system next to having a fixed administrative rank.

The terminal academic ranking system being applied and used at all Afghan state-run universities is a system for qualifying and promoting the teaching staff of every faculty. This ranking system is clearly defined in the Law book of the Ministry of Higher Education (MoHE 2015a). There is a monetary reward for achieving an academic rank. There is a set of regulations and certain requirements to be met in order to get a promotion and earn a terminal-academic rank.

Table 2.2 shows every title and minimum number of years required to achieve the promotion.

Academic Ranks at Afghan Universities

Title	English Translation	Years Required
Assistant		
Namzad-e Pohi'alay	Teaching Assistant Candidate	1 (Probationary)
Pohi'alay *	Junior Teaching Assistant	2
Pohanyar	Teaching Assistant	3
Pohanmal	Senior Teaching Assistant	3
Professor		
Pohandoy	Assistant Professor	3
Pohanwall	Associate Professor	3
Pohand	Professor	3

Table 2.2: Academic Ranking System's Titles

Earlier requirements and qualifications for becoming a faculty member were a Bachelor degree, an average of at least 75% of marks in all subjects through out the Bachelor programme, no failure in any subject and being below the age of 30. The applicant had to attend a competitive exam, earn the highest mark, do a presentation on a certain topic set by the exam jury and pass that successfully. The applicant then received a year of probationary period at universities where they had to work under the supervision of the department officer and other higher ranking colleagues. If his/her/their one year activities were evaluated positively, they would receive the faculty membership. Therefore the first Title is "Teaching Assistant Candidate". How-

ever, due to the new changes in the MoHE Law as well as the new decree of President Ghani (No. 74 Date: 02,09,2015)*, no one with a Bachelor Degree can apply for the faculty membership position. The applicant must have a Masters degree, the age limitation is set to 35 and the academic title the applicant would earn after the first year of probationary period would be "Teaching Assistant" (MoHE 2015a). These changes have reduced two years in earning a terminal rank in the academic ranking system and increased the maximum age limit for applicants, but they have also increased the challenges to study fields such as computer science, where the number of qualified Master graduates are very low currently. Faculties of Computer Science around the country do not offer Master study programmes and not everyone can afford to study for a masters degree abroad. However, President Ghani took the decree back and declared such newly established faculties as exception to the decree.

If a newly recruited candidate has obtained a Master degree already, that is evaluated as an equivalent to the terminal-academic rank of "Pohanyar ↬ Teaching Assistant", however, if a faculty member already has earned that title and achieves a Master degree, then s/he could use the Master thesis for being promoted to the next academic terminal rank "Pohanmal ↬ Senior Teaching Assistant" (MoHE 2015a). Similarly, a newly recruited candidate with a PhD degree would initially obtain the academic terminal rank of "Pohanmal ↬ Senior Teaching Assistant" and should the faculty member already have the terminal rank, then his/her PhD dissertation would count towards the next academic terminal rank of "Pohandoy ↬ Assistant Professor".

The recruitment process is always realized, observed and run through a department within the faculty. This requires existence of an administrative position within the organizational structure of the department. For example, if someone with a Master degree in Informatics wanted to work in the Faculty of Computer Science, one of the departments of Computer Science Faculty, i.e. Software Engineering, would have to offer a vacancy based on the existence of an administrative position within that department. MoHE has a clear regulation for the whole recruitment process that has to be completed and met before the new applicant is accepted as a faculty member. Despite running all the procedures and completing a huge folder of paper

*This decree was taken back in early 2017

work at the faculty level, the final approval has to come from the Ministry of Higher Education.

Table 2.3 lists all faculties and their relevant departments that are currently active at Herat University.

Table 2.3 Herat University's Faculties, Departments and Number of Students (HU 2015a)

No.	Faculty Name	Year	Departments Name	Students
1	Literature and Humanitarian Sciences	1988	Dari, Pashto, English, Arabic, German & Sociology	715
2	Fine Arts	1988	Calligraphy, Painting, Miniature & Graphics	257
3	Agriculture	1989	Agronomy, Plants Protection, Gardening, Animal Sciences, Agriculture Development, Soil Studies, Jungles and Natural Resources & Food Processing Technology	682
4	Economy	1990	Administration Economy, Public Economy, Banking & Business	848
5	Medicine	1990	Surgery, Inner Body, Children, Public Health and Infectious Diseases, Histo-patalogy, Anatomic Para-Clinic & Anatomy	946
6	Construction Engineering	1992	Civil Engineering, Architecture, Mechatronic & City Planning Engineering	705

7	Theology and Islamic Studies	1993	Islamic Law and Principles, Holy Koran Interpretation, Hadith (Sayings of the Prophet) & Islamic Culture	1101
8	Law and Political Sciences	2002	Public Laws, International Relations, Private Laws, Public Administration & Punishment Laws	672
9	Education	2003	Chemistry, Biology, Mathematics, Physics, Dari Literature, English Literature, Pashto Literature, History, Geography, Professional Trainings, Psychology, Consultancy & Sports	2377
10	Natural Sciences	2005	Mathematics, Physics, Chemistry, Biology & Food Processing Technology	1084
11	Computer Science*	2007	Software Engineering, Database and Information Systems, Communications and Operating Systems & Computer Engineering	479
12	Journalism and Mass Media	2011	Journalism & Public Relations	415

*For Details refer to the Section 4.3

13	Veterinarian Sciences	2011	Pre-Clinic, Para-Clinic, Food Processing Technology & Clinical Studies	205
14	Public Policy and Administration	2012	Public Administration, Development Management & Public Policy	619
15	Somatology	2013	Stomatology, Children Surgical OP & General OP	229
16	Social Sciences	2014	Sociology, History & Geography	483

Table 2.3: Herat University's faculties and their respective departments offering majors in different studies

2.5 Enhancing Afghanistan's IT Education

In the following subsections, a general picture of IT, its growth, importance and MoHE's attempt to addressing this issue is explained. A short history of the IT development (Section 2.5.1) in the country is depicted and the IT Strategic plan of MoHE is explained. In the shadows of this information the necessity for process improvement raises along side the IT requirements. However, often a Modern Afghanistan is pictured as a country that is equipped with modern state of the art hardware and software. Although this misconception has its roots back in the modern media sponsored by certain companies, importing modern hardware and software would only enhance the complexity of the puzzle.

After the start of the new era, which is considered the time frame between 2002 - 2021, the government has put high pressure on filling the gap between lack of IT experts in the country and the demanding job market. The post August-2021 government has not published any concrete plans, information or details on their approach towards this matter as of the time of this writing.

As fast as the IT is improving around the world and heading its way towards Afghanistan, drastic steps are also needed to be taken to improve the administration processes,

quality of education and maybe bring a change in the management concept all over and in particular in the IT education institutions that are responsible to steer the modernization generation of Afghanistan. In Chapter 3 - Section 3.1 various tools, methods and their possible contributions to the quality and process improvement are discussed.

2.5.1 IT and Afghanistan

Afghanistan's officially recorded touch with computers dates back to 1967. This coincides with the purchase of a Boeing airplane by the Afghan airline named Bakhtar back at the day. This company still runs under the name Ariana Afghan Airlines today. The computer was mainly used for billing or ordering airplane spare parts with the help of a software already developed in India (Peroz 1999).

The airline developed a partnership with the "Bank-e Melli Afghanistan" - Afghanistan's National Bank - to receive financial support for the acquisition costs of the system. This partnership resulted in the foundation of a computer teaching institute in Kabul later on, the first educational body contributing to IT education in the country (Peroz 1999).

The establishment of the Afghan Computer Center (ACC) in 1970 led the center to acquire membership of UNESCO (United Nations Educational, Scientific and Cultural Organization), RINSCA (Regional Informatics Network for South and Central Asia) and UNESCAP (United Nations Economic and Social Commission for Asia and Pacific) (Peroz 1999). Since the establishment of such an institute requires much financial support, Ministry of Finance, Da Afghanistan Bank, Ariana Afghan Airlines, National Insurance and Central Statistics Department showed interest in investing in the center in exchange for using the computers for their services. In the following, the main tasks are present that the center was used for(Peroz 1999):

- Keeping records on foreign trade,
- maintaining updated information of pension beneficiaries,
- issuing bills for public utilities,
- operating a database for Da Afghanistan Bank,

- maintaining a statistical database,
- managing the ticketing and reservation system for Ariana Airline.

Through out the years a number of other entities, i.e. hotels, ministries such as Foreign Affairs, Interior Affairs and Finance as well as private and international companies also showed interest in investing in this center and using the provided services for their own benefits. The 500.000 US$ worth IBM 360/30 was imported in January 1971 by the Afghan Business Machine, a joint venture founded by the Afghan National Bank, Ariana Afghan Airlines and Afghan Textile. The Intercontinental Hotel's location in Kabul was selected as the operation base for the mainframe computer due to its quality features such as air-conditioned rooms, power supply, security, cleanness and etc. Further computers and printers were later bought as an enhancement to the current IBM 360/30 computer. A number of young Afghans were sent to India to study computers for running and maintaining this center. A total number of 12 employees (five Afghans and seven Indians) were working as the center was established. (Peroz 1999)

One of the major achievements of this center was processing the national statistic project of the Central Statistics Department in 1978. UNDP (United Nations Development Programme) donated two IBM 34 and two printers to the center at the same time. The main idea behind all this was to turn this setup into the digital heart of administration and education in the study programme of computer science in Kabul. They named the educational part of this setup as "Afghan Computer Center" which was located in a building specifically for this purpose near "Hotel Ariana". The center was active in Kabul until 1992 . (Peroz 1999).

The Afghan Computer Center (ACC) purchased two mainframe EC-1055 systems from a German company in the early 1980s. The center owned 21 PCs and was active until 1991, and was closed down by Taliban two years later. The center offered hardware and software training programmes. It bought another two IBM 4381-R14 mainframes in 1992. Th United Nations Fund for Population Activities (UNFPA) and the Central Statistics organization had a plan to reactivate the center for the national census that was planned for mid 2005 (Marjan 2009). However, no official sources for the success or failure of the plan were found.

Afghan Computer Science Association (ACSA), a non-profit and non-political computer world trust, was founded in 1999. It aimed at introducing and motivating Afghan nation to explore the very new field of computer science and ICT(Marjan 2009). Kabul University got its first computer, the Commodore PET 2001 in 1979. The first lecture was then held in computer architectures. Dipl. Eng. Qasim Kutchke wrote a paper on components of a computer in 2000 (Yadav 2004).

Afghanistan went into a sudden political change (2002), which was accompanied by the fast paced growth of technology. Specially the growth rate of telecommunication technology has been drastically high in Afghanistan. A rapid telecommunication growth is documented since December 2001. The UN troops and the Afghan interim government of the time (2003/2004) got hands on an emergency network setup by Ericson telecommunication company. The company provided 200 telephones together with the necessary equipment and the UN sponsored the expenses for half a year (Marjan 2009; MCIT 2015).

The Afghan Wireless Communication Company (AWCC) is the first GSM mobile network provider company in Afghanistan that has been working since April 2002. The company was a joint venture of the Afghan government and the US Telco TSI. The company's initial coverage plan included cities such as Kabul, Herat, Mazar-e Sharif, Kandahar and Jalalabad. (Peroz 1999).

Due to the open market policy of the government, five GSM mobile network providers are providing GSM based mobile communication and Internet services today. The most recent statistics show approximately 24.1 million GSM, 1.8 million 3G services, 295000 CDMA and 105000 landline subscribers all over the country. These numbers show that 89% of the population have access to the telecommunication services(MCIT 2015).

The Telecommunication Training Center (TTC), which was a very effective center for training technicians and undertaking research, has been renovated and is now functional. The first training programme conducted at the center was the basic computer training provided to employees of the Ministry of Communications and Technology as well as government officials from other ministries (Marjan 2009; MCIT 2015). Furthermore, five state of the art IT Centers providing IT services were installed in Kabul, Herat, Nangarhar, Balkh and Kandahar universities. Establishment

dates are listed in the Table 2.4. An IT Competence Center for Higher Education has also been established in 2016 to promote IT research and education among young researchers of Afghanistan(ITCC 2016).

TU Berlin Backed IT Centres in Afghanistan - 2016

Name	Location	Establishment Date
ITCK	Kabul University	2003
ITCH	Herat University	2009
ITCN	Nangarhar University	2011
ITCB	Balkh University	2013
ITCQ	Kandahar University	2014
ITCC	Ministry of Higher Education - Kabul	2016 *

Table 2.4: Establishment of IT Centers around Afghanistan

Although the internal war that continued over a couple of decades (1988-2002) closed and destroyed universities, a severe brain drain was caused, but in the last 18 years, the country has stood back and universities develop and are slowly moving on to reach the state before outbreak of the war.

At the moment there are 36 government and 128 private universities and/or higher education institutions actively present in the country. Nine government universities as well as 34 private universities and/or higher education institutions (MoHE 2015b) offer Bachelor degree study programme in Computer Science. So far only one private university - Bakhtar Private University - offers Master degree study programme in computer science (MoHE 2015b). The highest number of institutions offering Computer Science studies are concentrated in the capital city of Afghanistan, leaving a big question on mobilizing IT Workforce around the country and rural areas for the future. That makes 5 state run and 23 privately owned institutions that offer computer science studies (MoHE 2016a). In the last few years there has been an initiative taken to apply a standard unified curriculum for computer science study programmes all over the country. For this purpose, Kabul University's computer science curriculum, which is an application oriented study programme, was selected. Later on major universities with international cooperation and collaborations were allowed to apply their own study programmes. This gave universities freedom in the choice of a study programme to offer (Peroz 2009b; MoHE 2015b).

2.5.2 MoHE & IT Strategy

Information Technology and its use for supporting the administration of Afghan government coincided with the establishment of the new government in 2002. As part of its development plans, the integration, use, development and facilitation of various IT projects have always been considered by the Ministry of Higher Education since the beginning of the new era. Different countries such as Germany, UK, India, Japan, South Korea, Turkey, USA, etc as well as organizations such as Cisco, DAAD, NATO, UNESCO, UNDP, USAID, World Bank etc. have contributed and supported IT projects for the improvement of Higher Education (Babury et al. 2012).

The MoHE's National IT Strategic Plan of 2008 focused on the following points (Babury et al. 2012) :

- "Establishment and expansion of an efficient infrastructure,
- development of Networks integrating all institutes of higher education,
- establishment of IT Centers at each institute of higher education,
- establishment of Computer Science Faculties,
- establishment of Computer Science Libraries,
- implementation of IT application in education and administration, and
- education and further training (Babury et al. 2012)".

The ministry had its achievements in the aforementioned targeted goals. Though not very fast, but partially one could name the NATO's Silk project. The Project had had already started in 2004. Later in 2013 the project was taken over by the Afghan Ministry of Communications and Information Technology with a financial funds provided from the National Development Grant. The grant was mainly used to provide Internet access to key Afghan universities around the country, establishment of a number of computer science faculties, i.e. Herat University, Nangarhar University and providing support to the Computer Science Department of Kabul University

as well as Kabul Polytechnic for being upgraded to a faculty. Given these achievements, the ministry set a number of high priority goals for its next Nationwide IT Strategy Plan 2010-2014 as follow: (Babury et al. 2012):

- "Establishing Afghanistan Research and Education Network (AfgREN),
- supplying all universities with computer equipment and strengthening the IT infrastructure,
- implementation of Higher Education Management Information System (HEMIS) and improving technical and users abilities in this regard.
- Training staff members to enable them use the modern technologies (Babury et al. 2012)".

The NATO's SILK Project (NATO 2018) provided network infrastructure in 22 further state-run universities in Afghanistan. Some 32.500 Public IPv4 were provided for the implementation of AfgREN. ANGeL Project (Afghan Next Generation E-Learning), a USAID funded project, provided several Afghan universities with a PC Pool that was then connected to the Internet via the NATO's SILK project. A bandwidth of 137 MBit/s with a total of 5.000 public IPv4 addresses and 20 video teleconference equipment systems were in use and operable by 2012 and the Ministry of Higher Education held regular video conferences with all universities around the country (Babury et al. 2012). HEMIS has been developed and is partially in use for beta testing in key universities around the country to find out further system bugs with actual test data.
IT Centre for Afghan Universities that are listed in Table 2.4 of Section 2.5.1 are state of the art, well equipped IT Centers that have been built so far. In terms of IT and Education more than 4.000 employees and students have received basic IT skills education. Around 100 IT professionals received special advanced trainings in IT (Babury et al. 2012). Faculties of computer science have been established and the number of computer scientists having a master degree in informatics has reached over 70 in all universities of the country. Some members are doing their PhD degree studies abroad at the moment.

To support and utilize IT into the administration of Afghan Universities, the MoHE has deployed an IT Department that is in charge of facilitation and providing IT support in various campus network, infrastructure, websites and hardware as well as software services to the university. This model started in 2004 at the MoHE itself and was expanded over the years to every university. Today, all state-run universities have a department/section within their administration structure for a group of IT specialists that provide the aforementioned IT support to the university (Babury et al. 2012).

The IT department is following a four-tier model that stands on an IT infrastructure of each university and their activities are categorized into four pillars. The pillars introduced in the IT Strategic Plan of 2012 (Babury et al. 2012) are more or less translated into the Afghan administration structure. Universities have hired professional IT experts in those sections. IT Security is concerned with all activities related to the security aspects of both hardware and software on and off the university network.

IT Administration deals with the modernization of Afghan government through the use of computer software and application i.e. websites and complex software systems like HEMIS.

IT Infrastructure looks after the network connection of the university, e.g. wireless, or through fiber cable. Anything between a user and their connection to the internet falls into the job description of this group, now taken the name NOC (Network Operation Center). The name comes after the NATO's SILK Project initiative and is still in use.

IT Education is responsible to provide education for the administrative employees and students of the university and to prepare them for using the IT infrastructure efficiently and responsibly (Babury et al. 2012). These pillars are supervised by an IT Officer at each university, who is responsible to keep the pillars working together and keep the IT infrastructure safe and running.

2.5.3 Summary

Chapter 2 presents and paves the way for understanding the current situation of Education System and IT status in Afghanistan. Discussing the topics mentioned in

this chapter is to give readers a clear picture of Afghanistan's education system and to present various options one could use to improve and optimize processes in order to improve the quality.

Presenting a detailed introduction to the top-down management system as well as the organizational structure is to give readers a feeling of how errands run in the government institutions in general and in particular in the Higher Education system of the country.

In the lights of IT Strategic plans of the MoHE with focus on further IT Development at the ministry and through its subbranches, the need to improve quality is raised even more.

The new Government of Taliban have not introduced any changes in the structural organization of the Ministry as well as the universities as of this date. The information that has been so far provided is talking about bringing changes in the curriculum and study program of the faculties in general where they are keen on removing certain subjects that they claim not to be in synch with their Islamic policies. The political changes have no direct impact on this work, however indirectly the achieved status quote at the time of the research may have been affected.

In the coming chapter readers will find out about the CMMI and the literature review in connection to the CMMI.

3

Process Improvement with CMMI

Chapter 3 presents the literature review on the topic of quality and quality improvements. Here the researcher has presented several methods and approaches that deal with quality improvement and finally presents a brief introduction to the CMMI (Capability Maturity Model Integration) and touches related research works which have tried to tackle the adaptability challenge of CMMI in different application areas. In the subsections of Section 3.1 quality improvement methods such as ISO Family have been introduced. Several methods that deal with quality improvement initiatives within organizations have been introduced to present a possibility of comparison between those methods. The CMMI frame work has been presented and various research works in regard to evaluating the role of CMMI in process improvement as well as adaptability of the CMMI into different application areas are discussed.

Section (3.2), (3.3) and (3.4) provides readers with a complete anatomy of CMMI's arrangements and give examples on how would CMMI identify processes and attach their relevant practices. However, if you are familiar with the CMMI and quality improvement models, you might as well want to skip the first sections and jump directly to section (3.5) where you can read about the current trends of CMMI, the lit-

erature review and what types of industries and businesses have tried to adapt CMMI and customize them to their own needs. The last section summarizes the chapter.

3.1 Call for Process Improvement

Considering the IT Strategy of the MoHE, there is a huge interest in further developing, offering better quality of service; but yet challenges are to face. Policy makers have taken an initiative to fill the gap for professional and skilled manpower by establishing computer science faculties around the country. They have turned into complex entities offering various services to their students. The recent technological advancements have made organizations highly dependent on various technologies; thus this dependency adds up on the complexity of the organizations. Every organization tries to use the most out of the available resources with the main goal of achieving success, whether this success is calculated in terms of quality of services offered or in terms of revenues made. Revenue in the context of Afghan IT Education institutions and faculties means to use the most out of the limited resources available to present a better prepared and skilled young generation to the Afghan society. Today, there are several models, standards and tools available to help these organizations offer their students quality services and product.*

Organizations in Afghanistan, cope numerous challenges, e.g. shortages in financial issue or the complex central administrative system, but what they all have in common is the wish to improve quality of their services and customize their processes. This being a core motivational factor for this thesis, the next subsections present various available options that could address quality improvement issues in an organization.

*For example, access to 100 Mbps Internet bandwidth might be considered a quality service a university can offer its students in Afghanistan, but that very same 100 Mbps bandwidth may not be considered a good quality internet access in a German University. Therefore, when discussing quality it is crucial to understand, know and consider the context in which we are using the term. It is hard to define the term "quality", but many scholars agree on conformance to requirements and fitness for use (Schwalbe 2013). If an item is fit for proper use and is made according to the requirement that was defined, then it is safe to say that particular item has a quality. However, quality still stays a relative term.

3.1.1 ISO

The International Organization for Standardization (ISO) is a well known entity in the world that has derived a set of standards based on clear and close collaboration of companies together with the contribution of experts from different fields to draw a maintenance line for defining, maintaining and producing quality products in all companies. Companies often seek this Organization's certificate for earning their customers trust and assuring them with production of a standard product.

ISO has driven its standardization process improvement documents and results from a set of well known and accepted quality management principles, that are identified and written down by international experts of ISOTC 176 (ISO Technical Committee 176).*. There are seven quality management principles that are the focus key for each ISO family standardization and quality management system: Customer Focus, Leadership, Engagement of People, Process Approach, Improvement, Evidence-Based Decision Making and Relationship Management (ISO 2015b).

ISO has managed to produce 17.800 † standards and related documents that contribute to economic, environmental and social consistent development. The ISOTC 176 has managed to introduce ISO 9000 family of standards that mainly targets the quality management system of companies or organizations. It has earned its reputation for providing a basis for establishing a quality management system that is effective and efficient (ISO 2009). The use of ISO 9000, which was first introduced in 1987, allows one to get a better grasp of the concepts and terminology used in the underlying quality management systems. It is also recommended to use the ISO 9000 family of standards in an integrated manner for earning better results in the quality improvement process (Hoyle 2001).

The following table Table 3.1 shows a list of ISO 9000 family of standards with their relevant version and target area (ISO 2009):

3.1 Current Standards from ISO/TC 176 (ISO 2009)

Standard/Document	Title	Edition

*ISOTechnical Committee 176 : ISOTC 176 is an entity within the ISO that is responsible for developing and maintaining ISO's quality management standards and the family of ISO 9000 falls under this committee's activities (ISO 2015b)

†As of Mid-January 2009

ISO 9000:2005	Quality Management Systems - Fundamentals and Vocabulary	Third
ISO 9001:2008	Quality Management Systems - Requirement	Fourth*
ISO 9004:2000	Quality Management Systems - Guidelines for performance improvement	Second
ISO 10001:2007	Quality Management - Customer Satisfaction Guidelines for Codes of Conduct for Organizations	First
ISO 10002:2004	Quality Management - Customer Satisfaction Guidelines for Complaints Handling in Organizations	First
ISO 10003:2007	Quality Management - Customer Satisfaction - Guidelines for Dispute Resolution External to the Organization	First
ISO 10005:2005	Quality Management - Guidelines for Quality Plans	Second
ISO 10006:2003	Quality Management - Guidelines for Quality	Second
ISO 10007:2003	Quality Management - Guidelines for Configuration Management	Second
ISO 10012:2003	Measurement Management Systems - Requirements	Second
ISO/TR 10013:2001	Guidelines for Quality Management System Documentation	First
ISO 10014:2006	Quality Management - Guidelines for Realizing Financial and Economic Benefits	First
ISO 10015:1999	Quality Management - Guidelines for Training	First

*June-2017: The Most Recent Version is published in 2015

ISO/TR 10017:2003	Guidance on Statistical Techniques for ISO 9001:2000	Second
ISO 10019:2005	Guidelines for the Selection of Quality Management System Consultants and Use of their Services	First
ISO/TS 16949:2002	Quality Management Systems - Particular Requirements for the Application of ISO 9001:2000 for Automotive Production and Relevant Service Part Organizations	Second
ISO 19011:2002	Guidelines for Quality and/or Environmental Management Systems Auditing	First

Table 3.1: ISO 9000 Family of Standards, Their Documents and Potential Targeted Area of Application (ISO 2009)

ISO 9001:2015 is the document containing base, vocabulary and standards for Quality Management Systems - Requirements. In this document the seven pillars of quality management principles, which are focused on and the requirements one needs to run a quality improvement effort in response to each pillar of the organization, are explained. Furthermore, the user can manage to apply this standardization at each step of his/her way (ISO 2015c). The ISO 9001:2015 standard is structured in eleven Clauses with each clause being responsible for handling certain part of the seven quality improvement principles. *

3.1.2 Known Methods and Tools dealing with Quality Management

Six Sigma is one of the known quality improvement and auditing tool in today's quality-centric movement of organizations and companies. Six Sigma is known as "a comprehensive and flexible system for achieving, sustaining and maximizing business success. Six Sigma is uniquely driven by close understanding of customer needs, disciplined use of facts, data, and statistical analysis, and diligent attention to managing, improving, and reinventing business processes.(Pande et al. 2000)"

*For further instruction and access on the material please refer to (https://www.iso.org/obp/ui)(ISO 2015a).

Six Sigma introduces a five-step improvement process abbreviated as DMIAC (Define, Measure, Analyze, Improve, and Control). This is an iterative process for continual improvement. It is scientific and fact based as well. Six Sigma can be used for design and development of a product or a service for the customer (Schwalbe 2013).

Schwalbe argues Six Sigma has its roots in Total Quality Management and Business Process Re-engineering and other older quality improvement initiatives; however she believes there are new improvements compared to those initiatives when it comes to Six Sigma (Schwalbe 2013). Six Sigma also needs the commitment of the top management as well as the employees. This method also requires a lot of training, which follows a "belt" system similar to a karate class. The more you get involved in training the higher the ranking of the belt goes. Organizations applying Six Sigma believe they can focus on the big picture and also consider the minute details. That is another good side of Six Sigma that allows organizations to focus on the main picture without loosing sight of the necessary details that contribute to the quality. Six Sigma is believed to be a philosophy that operates organizations with a focus on the customer, limiting mistakes and raising the level of quality as well as bringing financial benefits to organizations that follow this philosophy (Schwalbe 2013).
There are many quality management tools and/or methods that deal with quality improvement, auditing, monitoring and control. Here a number of them are briefly mentioned in order to give readers an overview.

Deming's 14 Points of Management (Deming 1986), Juran's 10 Steps for Quality Improvement (Juran and Godfrey 2000), Crosby's efforts for Zero Defects which is also following a 14 step quality improvement pattern (Crosby 1979), Ishikawa's guide to quality control that follows a cause and effect diagram pattern (Ishikawa 1986), Taguchi's opinion on robust design methods, where he believes quality should be built within the product and not looked for, by inspecting a product (Taguchi 1986), Feigenbaum's concept of total quality control that takes people who do the job responsible for quality (Feigenbaum 1991), Malcolm Baldrige National Quality Award* are some examples that shows how different scientists value reaching quality

*An award established by the U.S. Congress in 1987 to raise awareness of quality management and recognize U.S. companies that have implemented successful quality management systems (Heaphy and Gruska 1995). More on Malcolm Baldrige Award: https://asq.org//quality-resources/malcolm-baldrige-national-quality-award [Last Accessed: 04.Oct.2024 21:28]

and its importance. These are also tools or models that encourage organizations in taking an initiative for their process improvement efforts (Schwalbe 2013).

3.1.3 Process Improvement with CMMI

Organizations today, are complex entities offering various services to their customers. The recent technological advancements have made organizations - if not totally - partially dependent on various technologies, thus this dependency adds up on complexity of the organizations. Every organization tries to use the most out of the available resources with the main goal of achieving success, whether this success is calculated in terms of quality of services offered or in terms of revenues made. That entirely depends on the nature and structure of the organization.
Before discussing the origins, it is required to understand the core entity that derived everything up to now. As we know every organization is made up of people, tools and they have methods/procedures. These three basic entities comprise any organization around the world, be it a simple small school or a huge company like Google. All organizations share the same basic features to follow their goals. As described by Chrissis et.al; *process* is the core that holds all these three features together. (Chrissis et al. 2011). Process is in fact the way an organization acts and delivers its product. Success and failure of any organization depends on how good the process is carried out.

Figure (3.1) illustrates the inter-connectivity of basic organizational elements and their dependency on process as the core. The focus of models such as CMM* and/or CMMI† and many more is to improve the core for a better achievement of results. After several years of research and work on various ways of improving software productions, the Software Engineering Institute (SEI) of Carnegie Mellon University came up with the fact that due to the complex nature of organizations and their relation to their product as well as fast paced technological changes, the process improvement should be managed in an integrated manner. Thus, they patented and introduced their new model as CMMI, Capability Maturity Model Integration (Chrissis et al. 2011; Kulpa and Johnson 2003).

*Capability Maturity Model
†Capability Maturity Model Integration

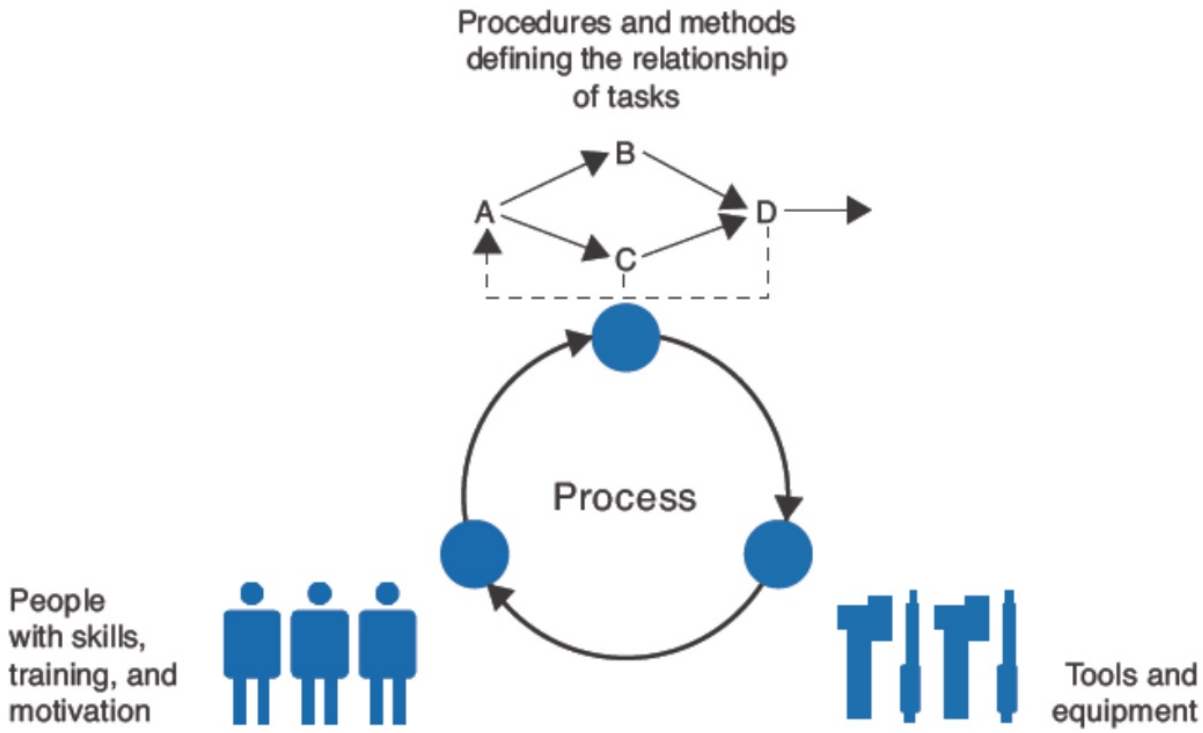

Figure 3.1: Defining Features of an Organization with Process as a Core(Chrissis et al. 2011).

Kulpa interprets CMMI as a merger of process improvement models for systems engineering, software engineering, integrated product development and software acquisition(Kulpa and Johnson 2003). This interpretation is in lights that some people consider CMMI as a model with multiple representations whereas others argue CMMI is a set of models (Kulpa and Johnson 2003). As the CMMI Institute defines CMMI, it "is a capability improvement model that can be adapted to solve *any* performance issue at *any* level of the organization in *any* industry (Institute 2017b)". As per The CMMI Institute's statistics, more than 5000 companies from more than 70 countries are adapting the CMMI for the quality improvement of their products (Institute 2016b). In order to understand CMMI, it is key to look at the origins of CMMI historically before a detailed explanation of CMMI is given.

3.1.4 CMMI Background

The Software Engineering Institute (SEI) of Carnegie Mellon University has conducted research on the improvement of CMMI for long and patented it with the US Trademark. Their unique way of the representation of the real world in the form of a simplified model makes this model interesting. That is why it is claimed adap-

tion of this model into any sort of organization is possible. SEI started their work based on the concepts of Crosby*, Deming†, Juran‡ and Humphrey§ (Chrissis et al. 2011). In the 1930s, Walter Shewhart began working in process improvement with his principles of statistical quality control. These principles were refined by W. Edwards Deming, Phillip Crosby and Josephy Juran. Watts Humphrey, Ron Radice and others extended these Carnegie principles further and began applying them to software in their work at IBM and the SEI (Chrissis et al. 2011).

CMMI for Development is a reference model that covers activities for developing both products and services. With its various adaptation possibilities it has been of high interest for organizations from many industries, including aerospace, banking, computer hardware, software, defense, automobile manufacturing and telecommunications(CMMI 2010b). This reference model is concerned with the quality of product and/or service in the aforementioned areas. Although, historically CMM for Software was meant to be used for the software production environment, the applicability of CMMI and its fame opened up a vast area of application. CMMI for Development contains practices that cover project management, process management, systems engineering, hardware engineering, software engineering and other supporting processes used in development and maintenance (CMMI 2010b).
The SEI's main focus was that "the quality of a system or product is highly influenced by the quality of the process used to develop and maintain it (Chrissis et al. 2011)". If the approach we make a system is managed and organized correctly and precisely, then the final product should be made well organized and thus we can produce a quality product. This way the time spent on maintenance is also organized systematically. Once the process of making a product is well defined and well established, the result should be good too. The very first CMM that was created and officially released by SEI was CMM for Software in 1993 (Chrissis et al. 2011; Kulpa and Johnson 2003).
It is required to understand the core entity from which everything is derived. In general three basic entities such as people, tools and methods/procedures comprise an

*Crosby, Philip B. - 1979
†Deming, W. Edwards - 1986
‡Juran, Joseph M. and Godfrey, A. Blanton - 2000
§Humphrey, Watts S. - 1989

organization to follow their goals. As described by Chrissis et.al; *process* is the core that holds all these three features together (Chrissis et al. 2011). Process is in fact the way an organization acts and delivers its product. Success and failure of any organization depends on how good the process is carried out.

CMM for Software started to open its way among software production organizations very quickly and an increasing number of companies started adapting this model to improve their software production. This quick popularity resulted in the development of various CMMs that targeted other types of organizations. The following CMMs were of high notice:

- System Engineering CMM (SE-CMM)
- Software Acquisition Capability Maturity Model (SA-CMM)
- Integrated Product Development Capability Maturity Model (IPD-CMM)
- System Engineering Capability Assessment Model (SECAM)
- Systems Engineering Capability Model (SECAM) (Kulpa and Johnson 2003)

All these different models initiated confusions for several models had to be used. To solve this issue, the SEI formed the CMM Integration project with the main focus to combine several selected models together. Several CMMs led to the integration and creation of CMMI. However, three main models contributed to the creation of CMMI for their successful adoption and/or promising approach to improving processes in an organization. Those three were CMM for Software V2.0c, SECM for Systems Engineering, Integrated Product Development - Capability Maturity Model (IPD-CMM) V0.98 (Kulpa and Johnson 2003; Chrissis et al. 2011; CMMI 2010b).

The first model of CMMI v1.02 was released in 2000 and addressed development organizations that wanted to improve processes. Version 1.1 was released a couple of years later followed by version 1.2 being released in 2006 (Kulpa and Johnson 2003; Chrissis et al. 2011). SEI planned on deploying two other models thus, named the original CMMI as the CMMI for Development and the two new models CMMI for Acquisition (released 2007) and CMMI for Services (released in 2009 and also based

on CMMI for Acquisition), both version 1.2 as they were based on CMMI for Development version 1.2 model. The most recent update of CMMI for Development, CMMI for Acquisition and CMMI for Services is version 1.3 released in November 2010 (Chrissis et al. 2011; CMMI 2010b). The newest version of CMMI 2.0 was released in 2018.

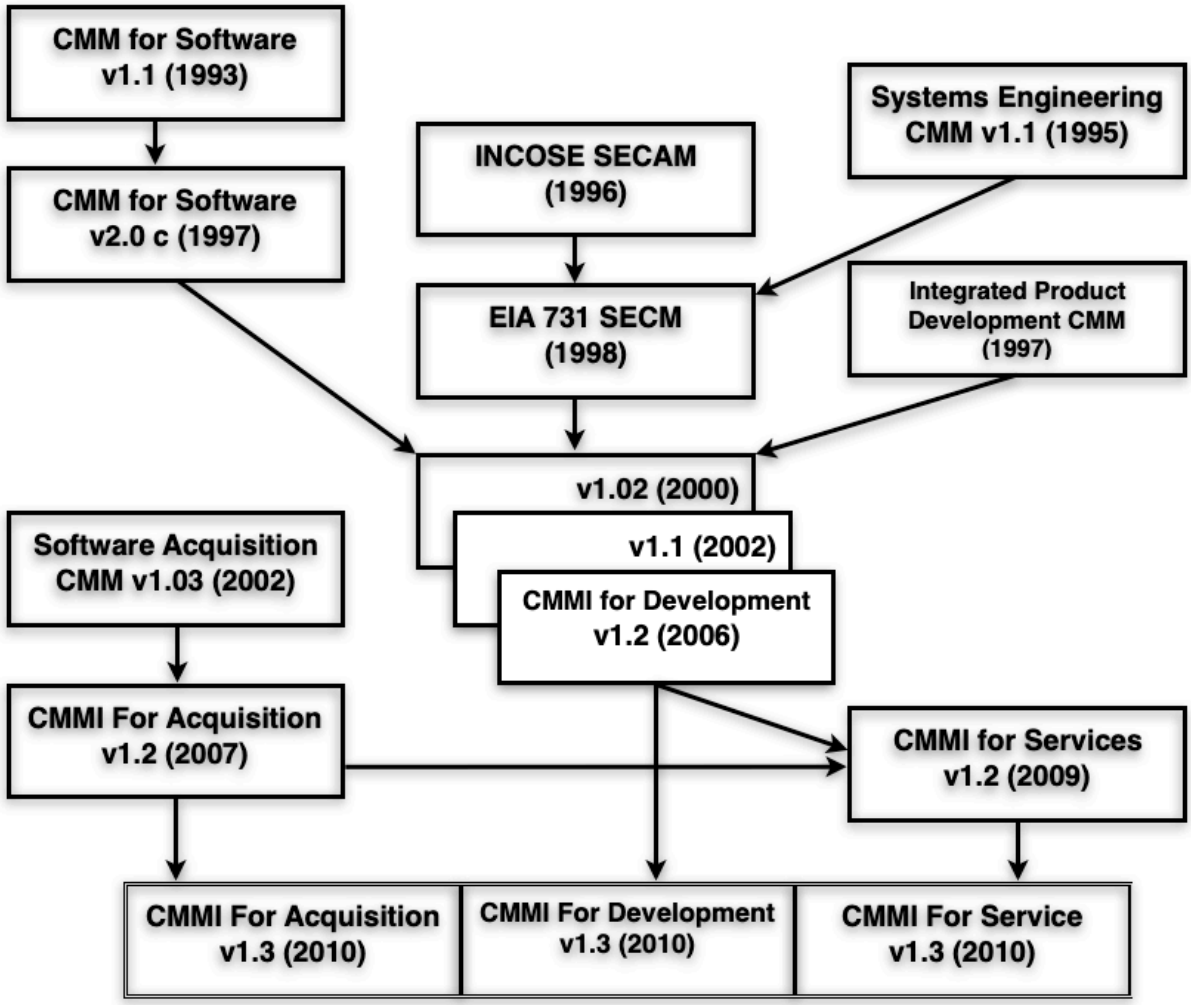

Figure 3.2: A detailed chart showing contribution of different CMMs to the creation of CMMI*. (Chrissis et al. 2011; CMMI 2010b).

The enterprise based process improvement is a key goal for companies. Based on the type of operation, availability of resources and goals of the organization, they choose a standardization model of their choice to improve their organization processes. Thus, different quality and improvement models presented in section (3.1) exist. As of 2007, the CMMI Product Team identified the following disciplines that were already covered with the model:

- Software Engineering

- Systems Engineering
- Hardware & Design Engineering
- Product and Service Design and Development
- Integrated Product and Process Development (IPPD)
- Acquisition
- Services Delivered (CMMI Product 2007)

Ever since, the CMMI Product Suite has been even more integrated, i.e. more core processes are included and bundled together. The official CMMI Product Suite contains CMMI for Development, CMMI for Acquisition and CMMI for Services all released in November 2010 with the version number 1.3 (Chrissis et al. 2011). In version 2.0 ISACA (ISACA 2020), the governing body of the CMMI Product has reportedly included an Online Model Viewer that includes CMMI for Development, Services and Supplier Management views. The Organization offers training courses in those specific components of the CMMI Suit as well. (ISACA 2020).

3.1.5 CMMI Product Suite - v1.3

"CMMI® (Capability Maturity Model® Integration) models are collections of best practices that help organizations to improve their processes. These models are developed by product teams with members from industry, government, and the Software Engineering Institute (SEI)"(CMMI 2010b).
The CMMI Framework is built to help interested parties with making CMMI based models, help themselves with trainings and use the appraisal components of the framework to evaluate the organizations compatibility with the CMMI. This framework allows the use of several models and thus the model components are categorized to be common to all CMMI models or certain specific models. Introduction of such a framework is necessary for understanding, learning, using and adopting this model. (CMMI 2010b) The well defined structure of CMMI model makes it over come the challenge of its adaptability to *"any"*(Institute 2017b) organization. The common material also known as "CMMI Model Foundation or the CMF"(CMMI 2010b) are part of every model that is derived from CMMI Framework.

3.1.5.1 CMMI for Development v1.3 (CMMI-Dev)

"CMMI for Development is a reference model that covers activities for developing both products and services. Organizations from many industries, including aerospace, banking, computer hardware, software, defense, automobile manufacturing, and telecommunications, use CMMI for Development."(CMMI 2010b)

This reference model is concerned with the quality of product and/or service in the aforementioned areas. Although, historically CMM for Software was meant to be used for software production environment but the applicability of CMMI and its fame has opened up a huge area of application. CMMI for Development contains practices that cover project management, process management, systems engineering, hardware engineering, software engineering, and other supporting processes used in development and maintenance. (CMMI 2010b)

3.1.5.2 CMMI for Acquisition v1.3 (CMMI-acq)

"Acquisition projects are complex because they are directed outward and inward. They are directed outward, toward acquiring products, systems, services, and capabilities to meet a set of operational expectations. They are directed inward toward ensuring that the acquisition process is conducted with discipline. The CMMI-ACQ model incorporates this duality by recognizing that some activities are under the direct control of the acquisition project, while others involve monitoring or facilitating the success of external partners and suppliers."(Phillips 2011)

Projects often have to deal the constraints such as performance, cost and time to proof themselves for having a good quality. Despite that acquisition leaders create a flexible environment for acquisition projects while drastically decreasing acquisition cycle times and improving credibility. Rising levels of product and service complexity; increasing software contribution to overall system functionality; demands for agile, adaptable products; and shortened delivery time-frames place stress on existing acquisition practices.(Phillips 2011)

The CMMI-ACQ model is designed to influence the outcome of the acquisition process so that it delivers the right capabilities to users on schedule and at predictable costs through the disciplined application of efficient and effective acquisition pro-

cesses. Applying this approach requires a dedication to defining, implementing, measuring, and maintaining the acquisition processes that are fundamental to a technically sound project.(Phillips 2011)

"General Motors partnered with the SEI to create the initial Acquisition model draft that was the basis for this model. The model now represents the work of many organizations and individuals from industry, government, and the SEI."(CMMI 2010a) The CMMI Steering Group initially approved a small introductory collection of acquisition best practices called the Acquisition Module (CMMI-AM), which was based on the CMMI Framework. While it described best practices, it was not intended to become an appraisal model nor a model suitable for process improvement purposes.(CMMI 2010a)

CMMI for Acquisition is a reference model that covers the acquisition of needed capabilities. Capabilities are acquired in many industries, including aerospace, banking, computer hardware, software, defense, automobile manufacturing, and telecommunications. All of these industries can use CMMI-ACQ.(CMMI 2010a)

3.1.5.3 CMMI for Services v1.3 (CMMI-Svc)

One of the natures that can be found in any organization is the services they offer their customers. Services have an impact on the global economic growth, since they are the optimal result every organization tries to reach. It is important to follow known mature service practices and trying to improve and develop them since this approach enhances performance and as a result makes the customer happy. That is why the SEI's CMMI Product Team has arranged the CMMI for Services (CMMI-SVC) model that targets development and improvement of services an organization offers. (CMMI 2010c)

CMMI-SVC model considers and focuses on service providers activities. Therefore, the service oriented organizations can easily use this model to improve their processes. Next to the 16 common process areas that are common among all CMMI models, there are some seven process areas that focus on service specific practices. They are namely addressing capacity and availability management, service continuity, service delivery, incident resolution and prevention, service transition, service system development, and strategic service management processes. (CMMI 2010c)

The CMMI for Acquisition model was released in 2007. Since it is built on the CMMI for Development Version 1.2 model, therefore Version 1.2 was set for it as well. Two years later the CMMI for Services model was released. CMMI for Services model builds up on the other two previous models and thus also gets version 1.2 as it was introduced. (CMMI 2010c; Chrissis et al. 2011)

CMMI-SVC draws on concepts and practices from CMMI and some other service focused standards and models, including the following (CMMI 2010c):

- Information Technology Infrastructure Library (ITIL)
- ISO/IEC 20000: Information Technology - Service Management
- Control Objectives for Information and related Technology (CobiT)
- Information Technology Services Capability Maturity Model (ITS-CMM)

Knowing all the previous service concentrated models and standards is not necessary for applying and/or using CMMI-SVC model. The CMMI-SVC model covers the activities required to establish, deliver, and manage services. As defined in the CMMI context, a service is an intangible, none store-able product. The CMMI-SVC model considers this definition of service at all stages. (CMMI 2010c)
"CMMI-SVC goals and practices are therefore potentially relevant to any organization concerned with the delivery of services, including enterprises in sectors such as defense, information technology (IT), health care, finance, and transportation. Early users of CMMI-SVC include organizations that deliver services as varied as training, logistics, maintenance, refugee services, lawn care, book shelving, research, consulting, auditing, independent verification and validation, human resources, financial management, health care, and IT services."(CMMI 2010c)

3.2 Anatomy of CMMI

The core material for all CMMI models is the process. CMMI models original goal is to improve processes. The CMMI Framework is the generator of all CMMI models. All the goals and practices that are required for producing CMMI models are collected in this framework. Organization activities are mapped into process areas

that cover basic concepts for process improvement. ”A process area is a cluster of related practices in an area that, when implemented collectively, satisfies a set of goals considered important for making improvement in that area.”(CMMI 2010b; Chrissis et al. 2011) In general there are 16 core process areas. Some material in those core process areas are common across all CMMI models, where as some are customized to the specification of the model in use. (CMMI 2010b)

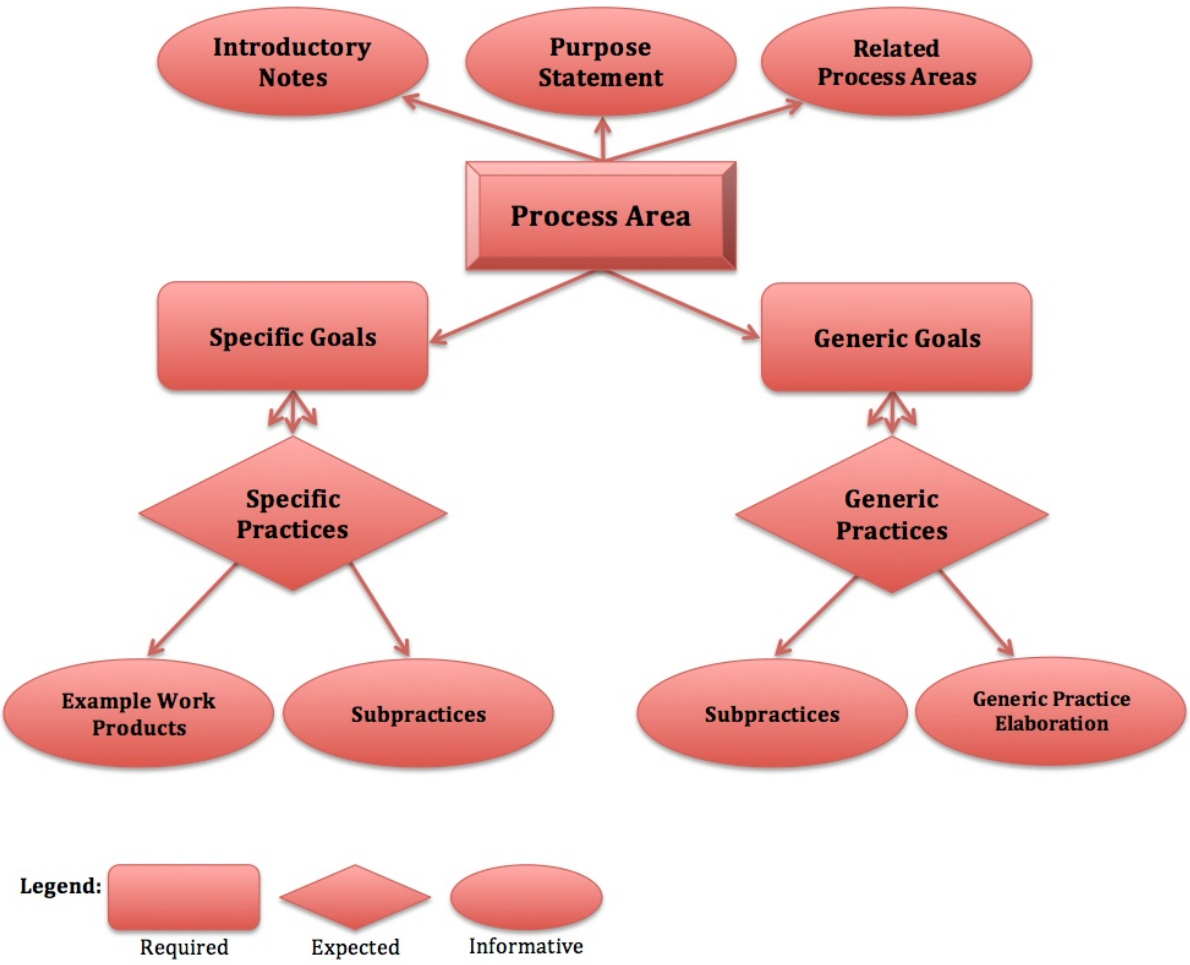

Figure 3.3: CMMI Model's Components in a diagram (Chrissis et al. 2011; CMMI 2010b).

Figure (3.3) shows representation of a process area and its related information in a single diagram, here each component of the diagram is explained briefly.
In order to make the interpretation of these process areas easy, they are grouped into three categories - required, expected and informative components. The *required components* are those CMMI components that are needed to achieve process improvement in a certain process area. CMMI needs these components and thus they have to be clearly implemented and in operation in an organization's processes. The

required components are also denoted in CMMI models as the generic and specific goals. These goals form the foundation for the appraisal to figure out whether process improvement has been achieved or not. (CMMI 2010c;b)

The *Expected Components* are a blueprint for those who are applying the process improvement on required components. These components serve as a light tower and describe the way how the required components should be improved after the process improvement has been completed. There is a small condition for the expected component and that is either practices as described in the CMMI Model or similar acceptable alternatives to those practices must exist or at least be planned in the organizations. (CMMI 2010a;b)

Informative Components are part of the CMMI model to give the model users an insight in the form of examples, extra information or explanations, so that the model user can get an idea what the process area is all about. These informative materials target the CMMI model implementer and users. (CMMI 2010c;b; Chrissis et al. 2011)

Process Area: There are 22 process areas in CMMI for Development model and they are listed here sorted by the acronym of the process area (CMMI 2010b):

1. Causal Analysis and Resolution (CAR)
2. Configuration Management (CM)
3. Decision Analysis and Resolution (DAR)
4. Integrated Project Management (IPM)
5. Measurement and Analysis (MA)
6. Organizational Process Definition (OPD)
7. Organizational Process Focus (OPF)
8. Organizational Performance Management (OPM)
9. Organizational Process Performance (OPP)
10. Organizational Training (OT)
11. Product Integration (PI)

12. Project Monitoring and Control (PMC)
13. Project Planning (PP)
14. Process and Product Quality Assurance (PPQA)
15. Quantitative Project Management (QPM)
16. Requirements Development (RD)
17. Requirements Management (REQM)
18. Risk Management (RSKM)
19. Supplier Agreement Management (SAM)
20. Technical Solution (TS)
21. Validation (VAL)
22. Verification (VER)

Purpose Statement: It describes the purpose of the process area and is an informative component. This is normally stated in the form of one sentence. For example the purpose of Project Planning (PP) process area reads as " Project Planning (PP) is to establish and maintain plans that define project activities. (CMMI 2010b; Chrissis et al. 2011)

Introductory Notes: The introductory notes section of each process area describes the major concepts covered in the process area and as can be seen in the diagram (Figure 3.3) is an informative component. It helps the user to understand what the process area is about. Taking the Project Planning (PP) for instance, the introductory notes gives further explanations. Taken this example it emphasizes on the effective management of project using proper project planning methods and it lists a number of activities that has to be considered in the planning .i.e. Developing the project plan; Interacting with relevant stakeholders appropriately; getting commitment to the plan; maintaining the plan. (CMMI 2010b; Chrissis et al. 2011)

Related Process Areas: Also an informative component and it lists references to related process areas and reflects the high-level relationships among the process areas. For example *Requirements Development*, *Technical Solution*, *Measurement and*

Analysis, *Requirements Management* and *Risk Management* process areas are related to Project Planning (PP) process area. (CMMI 2010b; Chrissis et al. 2011)

Specific Goals: It is a required component and describes the unique characteristics that must be present to satisfy the process area. This component is mostly used in appraisals to find out if requirements of a process area are met. For example the Project Planning (PP) process area has three specific goals namely SG 1 Establish Estimates, SG 2 Develop a Project Plan and SG 3 Obtain Commitment to the plan. For each of these specific goals a detailed description is provided. SG 1 requires that "Estimate of project planning parameters are established and maintained"(CMMI 2010b) This specific goal (SG 1) is further explained with what kind of activities should be carried out and what type of documents should be presented. (CMMI 2010b; Chrissis et al. 2011)

Generic Goals: The reason they are called "generic" is because the same goal statement can apply to multiple process areas. Here certain characteristics are described that are used for establishment of processes that are required for the implementation of a process area. Generic goals are also the required component of the CMMI model. For instance one could point to GG 1 Achieve Specific Goals. As one should always keep in mind generic goals are stated in the form of a pure statement all the extra information turns out to be informative components within the generic form. Therefore, the statement of GG 2 reads as "The process is institutionalized as a managed process".(CMMI 2010b; Chrissis et al. 2011)

Specific Practices: This is an expected component of CMMI model. Specific practices are description of an activity that is considered important in achieving the associated specific goal. These practices are the optimal result and/or futuristic image of the specific goal. These explanations of the specific goals show how the undertaken process area would look like after improvement. For instance the SG 1 has listed four specific practices that has to be reached in order to do the appraisal and achieve the desired process improvement. One of these specific practices is "Define Project Lifecycle Phases (SP 1.3)", which is to "define project life-cycle on which to scope the planning effort."(CMMI 2010b) It is further explained in details to give an insight to the user for understanding it properly.

Example Work Product: This is an informative component of the model and helps

the user to understand the specific practice by example where it lists sample outputs. For instance the outcome sample result that is expected from the "SP 1.3 Define Project Life-cycle Phases" will be the life-cycle of the project in discussion, in this example it is only one item that reads as "1. Project life-cycle phases" (CMMI 2010b; Chrissis et al. 2011)

Sub-practices: This informative component of the model is to provide detailed explanation to guide the user to understand and implement a specific or generic practice. Sub-practices are meant to give the user some useful ideas for process improvement. For example consider the specific practice "SP 1.1 Estimate the Scope of the Project", for this specific practice four sub-practice are introduced that stress the need for the information packages to be created to carry out the SP 1.1. For instance we could name the first sub-practice (i.e. 1. Develop a WBS) related to the SP 1.1. A work breakdown structure (WBS) is used to organize the project's work, thus yielding to understand the scope of the project better as well. (CMMI 2010b; Chrissis et al. 2011)

Generic Practice: It is an informative component of the model and like in the definition of generic goals, generic practices are called generic because the same practice applies to multiple process areas. Generic practice is always associated with the relevant generic goal and it describes activities that are considered to be important for realization of the generic goal it is associated to which eventually leads to the institutionalization of processes associated to the relevant process area. For example the generic practice GP 2.1 Establish an Organizational Policy comes up with a purpose of defining the organizational expectations for the process and make those expectation visible to those members of the organization who are being affected and thus this generic practice states as "Establish and maintain an organizational policy for planning and performing the process. (CMMI 2010b; Chrissis et al. 2011)

Generic Practice Elaborations: They always appear after generic practices with the aim to provide guidance on how the generic practices can be applied uniquely to process areas. As also shown on the diagram (Figure 3.3), it is an informative component of the model and serves only to provide further information and helps the user understand the process area better. (CMMI 2010b; Chrissis et al. 2011)

Additions: Not always present with every process, they are clearly marked model

components that can be informative material, specific practice, a specific goal or an entire process area and it contains interesting information for particular users. However, a point worth mentioning is that there is no Additions in the CMMI-DEV model. (CMMI 2010b; Chrissis et al. 2011)

Next to these model components, one can come across other supporting informative components such as *Notes*, *Examples*, *References*. They all serve the purpose of providing further helping information to the user. They can be in the form of a text, a list of items - usually shown in a box - or a pointer referencing to additional or more detailed information related to the process areas. (CMMI 2010b; Chrissis et al. 2011)

3.3 Putting Everything on a Track

The CMMI has considered two approaches for an evolutionary process improvement within any organization, both separated into levels. These levels are also a basis for the appraisal result where the organization receives a certificate that specifies which level the organizations' process improvement has reached after applying the appraisal (CMMI 2010b; Chrissis et al. 2011).

"CMMI supports two improvement paths using levels. One path enables organizations to incrementally improve processes corresponding to an individual process area (or group of process areas) selected by the organization. The other path enables organizations to improve a set of related processes by incrementally addressing successive sets of process areas."(CMMI 2010b; Chrissis et al. 2011)

These approaches enable companies to decide whether they want certain processes or a group of processes to be improved at the same time. These two improvement approaches are further categorized into capability levels and maturity levels. The two levels are then again mapped to two process improvement approaches which are called "representations" in the CMMI Product Suite's terminology (CMMI 2010b; Chrissis et al. 2011). The two representations are called "continuous" and "staged", leaving the user with a choice to select between the two. The "continuous" representation leads you to the achievement of "capability levels" whereas the "staged" representation leaves you with achievements in the "maturity levels" (CMMI 2010b;

Chrissis et al. 2011). This representation is often confused as being unrelated to each other, which is not the case. The representations are made to give the organization a freedom of choice where they want their process improvement goals to be applied to and what process or group of processes to be considered for the process improvement efforts. They both provide organizations with tools to improve their processes and have better business outcomes while both give companies the same essential contents and model components to be used (CMMI 2010b; Chrissis et al. 2011).

The continuous representation (Capability levels) focuses on individual process areas for improving processes within an organization, whereas the staged representation (Maturity levels) focuses on multiple process areas within an organization simultaneously. The later lets the organization have the freedom to apply process improvement schemes over multiple process areas at the same time; the earlier focuses on one process area at a time. Both representations are required for the appraisal methods, thus, the organization that is willing to gain a certain level and to improve their processes, should choose one of the two approaches and focus its process improvement goals accordingly. The capability levels are meant to improve a given process area incrementally; hence, the numbering of the levels is from 0 to 3. The maturity levels let the company focus on several process areas at the same time, they are numbered from 1 to 5. The Continues approach focuses on the capability of a certain process, whereas the Staged approach focuses on the Maturity an entire group of processes yielding to the overall improvement of an organization as a result(CMMI 2010b; Chrissis et al. 2011).

The following table (Table 3.2) shows the two approaches and each level's or stage's name tag.

CMMI Representations

Level	Continuous Representation (Capability Levels)	Staged Representation (Maturity Levels)
Level 0	Incomplete	
Level 1	Performed	Initial
Level 2	Managed	Managed
Level 3	Defined	Defined
Level 4		Quantitatively Managed
Level 5		Optimizing

Table 3.2: The Representations of CMMI and their Relevant levels

In order to apply any of the two approaches, we should get a clear grasp of what each level means in general and then what would they mean in respect to each other. As discussed earlier the Capability levels target process improvement across single processes one at a time, that is why it is called the Continuous approach as well. The four capability levels numbered 0 through 3 considers one individual process for improvement. Once the organization chooses a process to be improved, the appraisal team (whether internally appointed or outsourced) will examine the given process across each level until they can determine the current improved status of the process and only then they can suggest solutions on what aspects of the process to be improved before the process improvement level can be upgraded. The beauty of this approach is that during an appraisal sequence one process could get Level 3, which is the top level capability, where as the next process might get a level 1 or Level 0 *Incomplete* identification code. This approach lets an organization figure out its strength and weakness parallel and the organization could focus on improving the weaknesses.

Capability Level 0: Incomplete considers a process *Incomplete* under the circumstance that it is not performed or it is partially performed. In this level one or more specific goals of the process area are not satisfied and in this level no generic goal for the process area exists yet. It makes sense not to give a higher level to a process area where it is not performed or partially performed(Chrissis et al. 2011; CMMI 2010b). The next level in this approach is named *Capability Level 1: Performed*. When a process reaches and/or is entitled with this level, then it is characterized as *performed process*. This means that the process can accomplish the needed work for producing the work product. In this level the process area's specific goals are met. In order to maintain the improvements that are reached at this level, it is necessary to upgrade to the next two Capability levels, as their generic practices help ensuring the improvement stays and the process area produces the quality products as expected (Chrissis et al. 2011; CMMI 2010b).

A process area can reach the next level, which is called *Capability Level 2: Managed*, when it is already in Level 1: *Performed* state and it is planned and executed in accordance with the policy. The process area employs skilled workers and provides them with enough resources so that they can produce controlled outputs. The process

area in this level keeps all the stakeholders involved, it is well monitored, controlled, reviewed and constantly evaluated. The process area sticks to its original description and doesn't go out of the line. (Chrissis et al. 2011; CMMI 2010b)

Capability Level 3: Defined is the last level in this approach. A process can be considered defined that has already passed the qualification for Performed or the Level 2 criteria. Such a process is in fact made out of the organization set of standard processes according to its guidelines. A process in such a level is expected to have maintained a clear process description and contributes to the process related experiences of the organization. A process reaching at this level would have passed all the improvement path and would have reached to its almost perfection. It is like an artist's final touch to his painting to make sure everything is perfect and painted according to his visionary image. (Chrissis et al. 2011; CMMI 2010b)

There is a very narrow difference between capability levels 2 and 3 that one should consider carefully. The two levels can be differentiated by the scope of standards, process descriptions and procedures. These are the differentiating points of the two levels. The three differentiating parts at capability level 2 can be quite different in a sense that they depend on each specific instance of the process, let's say on a particular project, where as at capability level 3 these three points (standards, process descriptions and procedures) for a project are matching the organization's standard processes in order to suit a particular project or organizational unit (Chrissis et al. 2011; CMMI 2010b).

There is yet another important difference between the two levels and that is at capability level 3 processes are described more delicately. In Level 2 one can easily and clearly find the purpose, inputs, entry criteria, activities, roles, measures, verification steps, outputs and exit criteria of a process. At Capability level 3, processes are managed more proactively using understanding of the interrelationship of the process activities and detailed measures of the process and its work products. (Chrissis et al. 2011; CMMI 2010b)

In order to apply these levels to a process area within an organization, you can use the generic practices or suitable alternatives to the processes associated with that process area in discussion. A process area can reach capability level 1 when all the processes which are associated to that process area are performed processes. Meaning

they meet the requirement of Level 0 already. This explanation clears out the presumption that any organization which has a process area, then considered process area is in *Level 0*. Since *level 0*'s requirement is only to have a process area, whether all its processes exists are just some or none, the process area falls in this level, the Incomplete. Therefore, once a process area is notified and all its processes are distinguished and known and ready to perform, the process area in discussion qualifies to move on to level 1, Performed.

The transition from Level 1 to Level 2 depends on whether a policy that would indicate that you are performing the process exists and is in order. Next to the policy, you need a plan for how you are going to perform the process, the organization has required resources for performing the process in the right manner as defined in the policy and plan; the people who are carrying out those performances are identified and ready, the people are given training on how to correctly perform the process area; certain work products that are related to this performance is selected and are controlled accordingly. A capability level 2 process can be planned and monitored just like any project or support activity. (Chrissis et al. 2011; CMMI 2010b)

Once an organization's process area reaches Capability level 3 it would mean that the organization has a standard process that can associate with the process area in discussion and together this can be matched to the project's needs. At this level the organization has clearly defined processes and standards that could be applied regularly (Chrissis et al. 2011; CMMI 2010b).

The second approach in CMMI's process improvement model is the *staged* approach. This approach is designed in the form of Maturity levels and thus applicable to a set of predefined process areas that would yield to an overall improvement of an organization's performance. The Maturity level is made out of related specific and generic practices that allow the company to target a group of process areas together at the same time. The staged approach might sound high demanding as a manageable number of process areas should be grouped together and worked on at one time, but then they contribute to the overall process improvement of the organization's goals and targets. In this approach each level matures an important subset of an organization's processes that will prepare them for the next maturity level. One can measure the maturity levels by considering how far the specific and generic goals for

each predefined set of process areas are achieved. As seen in Table (3.2), the maturity levels are numbered 1 through 5 with each level being a foundation for the ongoing process improvement. Capability levels and maturity levels are complementary to each other and this fact is once again reflected in keeping a consistent terminology across the naming selection for the two approaches. As seen in Table (3.2) maturity level 2 and 3 are using the same terms as capability levels 2 and 3. This is not a coincidence, but a deliberate choice of naming levels. "Maturity levels are used to characterize organizational improvement relative to a set of process areas, and capability levels characterize organizational improvement relative to an individual process area." (Chrissis et al. 2011; CMMI 2010b)

Maturity Level 1: Initial In this level, processes are usually chaotic and dealt with less care and on a daily basis. The organization fails to provide a stable environment for supporting processes. The organizational success or failure is directly measured and it stands on the performance, ability and action taste of the people involved in the organization. It is the people who define the status of the organization. Once the person is replaced by someone new, since the lack of proven processes exists; the new person chooses to manage and run the processes how and what he finds fit for use. It is mostly dealt with on personal taste of running the organization. An organization that is at this level, still runs, have services and produces products, but what fails with those organizations the most is either exceeding the budget required earlier, or in some examples, can not spend the allocated budget that was planned and documented. (Chrissis et al. 2011; CMMI 2010b)

Maturity Level 2: Managed and *Maturity Level 3: Defined* are just the same as Capability Levels 2 and 3, with the slight difference that the former is applied on a set of related process areas where as the later is applied on a single process area at a time. In other sense both serve the same purpose as of Capability levels 2 and 3. (Chrissis et al. 2011; CMMI 2010b)

Maturity Level 4: Quantitatively Managed This level means the organization and projects have already met requirements of the earlier levels and now they can set quantitative objectives for quality and process performance and these quantitative objectives can be used as a criteria to better manage projects. How to set those quantitative objectives depends on customer, end users, the organization itself and pro-

cess implementer needs. The needs of these groups can be the defining criteria for the quantitative objectives. The quality of product and the process performance is considered in terms of number throughout the life of the project. This level deals mostly with numbers and statistics that are collected through process performance and analyzes them. The key to correctly running and assuring to reach this level is to understand the relationships between the subprocesses that are selected for process improvement and how they can affect the quality of process improvement after the entities are being selected. One major difference between maturity level 3 and maturity level 4 is the predictability of process performance. At level 4 the performance is controlled using quantitative techniques and predictions are mostly made based on the collected process data. (Chrissis et al. 2011; CMMI 2010b)

Maturity Level 5: Optimizing is mostly concerned with continually improving processes based on a quantitative understanding of its business and objective needs. This level focuses on continually improving process performance through incremental and innovative process and technological improvements. "The organization's quality and process performance objectives are established, continually revised to reflect changing business objectives and organizational performance, and used as criteria in managing process improvement." The effects are always measured using quantitative techniques. Maturity level 5 aims at project's defined processes, the organization's set of standard processes and supporting technology and uses them as measurable improvement activities. "A critical distinction between maturity levels 4 and 5 is the focus on managing and improving organizational performance. At maturity level 4, the organization and projects focus on understanding and controlling performance at the subprocess level and using the results to manage projects. At maturity level 5, the organization is concerned with overall organizational performance using data collected from multiple projects." (Chrissis et al. 2011; CMMI 2010b)
The Maturity levels are structured so that at the beginning the organization will focus on improvement of the project and then the whole organizational quality using a more qualitative approach and then at the later levels focuses on quality improvement using more quantitative techniques. This way the organization can make its decisions using qualitative or quantitative data that it has in hand. The organization can improve its processes using both methods, depending on which stage/level the

process improvement initiative exists.

In such scenarios, the maturity of one project yields to quality products and since a set of process areas are being improved at this approach, then they all together contribute to the overall quality of the organization, letting the organization to have a better and improved environment for running its processes. For example, when maturity level 2 is reached, that shows the organization has managed to apply sound management standards to bring the organization from a chaotic personal-taste-dependent state to a more disciplined system-dependent state. At such point the organization's processes would follow a systematic and well organized approach rather than just running the daily based chores in a person-centric approach. The maturity levels are built on each other, hence skipping one level wouldn't help in organizational improvement and that would fail to obtain the organization's goal for improvement. One should also keep in mind that the bundled process improvement approach that is feasible by the Maturity Levels approach, helps with the organization's general situation towards better product development. This should be taken into account that the process improvement must focus on the organization's needs in the context of what this organization provides and offers. The higher maturity levels should be able to take care of both the current needs of the organization as well as they should not overlook the future needs of this organization. This should let the organization to choose certain groups of the processes together to match one process area.

3.3.1 Process Areas

CMMI Product suit handles process areas in the two representations differently. For those organizations that choose the Continuous representation, the process areas are arranged into four categories. Those categories are namely Process Management, Project Management, Engineering and Support. They are categorized in this way due to the key relationships in between process areas. This way the continuous representation lets the organization to focus on improving processes that will contribute to the business objectives of the organization. (Chrissis et al. 2011; CMMI 2010b)

On the other hand an informal grouping of process areas that is called high maturity process areas are also used in this context. This informal grouping is named as Orga-

nizational Process Performance, Quantitative Project Management, Organizational Performance Management and Casual Analysis and Resolution. These grouping of process areas are based on the improvement of those processes that would contribute mostly to the success quality of organization's business objectives. (Chrissis et al. 2011; CMMI 2010b)

These groupings are just to give an organization that wants to apply process improvement an ease of use on where to begin and which processes to consider. The capability levels as well as the generic goals and practices are meant to support the process improvement associated with an individual process area. For instance, an organization wants to reach capability level 2 in process area X and capability level 3 in processes area Y. The organization manages to reach those level target that were set and now it decides to go for another process area or widen its target list and increase the number of process areas it wants to improve. Now lets suppose that this organization managed to improve all of its process areas or at least most of its process areas and reached capability level 3, then here the organization has the chance to focus on shifting up to high maturity process areas and start improving them further with the head start point set already at capability level 3.

As we know the staged representation gets labeled after its maturity level, since this approach concentrates as well as contributes to the overall maturity of the process which again on their own contribute to the maturity of the organization. The maturity levels are numbered 1 to 5 and the transition from one level to the next requires meeting the goals of each maturity level. "For example, at maturity level 2, there is a set of process areas that an organization would use to guide its process improvement until it could achieve all the goals of all these process areas. Once maturity level 2 is achieved, the organization focuses its efforts on maturity level 3 process areas, and so on. The generic goals that apply to each process area are also predetermined. Generic goal 2 applies to maturity level 2 and generic goal 3 applies to maturity levels 3 through 5." Process areas are also categorized into the four groups namely Support, Project Management, Process Management and Engineering. This categorization is mainly done after the application and use of the process area. This way it is easier to understand the process areas and its relevant area of application. (Chrissis et al. 2011; CMMI 2010b)

As far as it has been cleared, organizations have the freedom to choose applying staged representation or the continuous representation. However, it is also possible that an organization starts with continuous representation and at certain capability level decides to switch to staged representation in its path to process improvement effort. For such scenarios the "Equivalent Staging" approach is used. This is basically set of rules and measures that allows one to translate capability levels to maturity levels or vice versa. The following is basically a summery of the rules that makes the translation possible (Chrissis et al. 2011; CMMI 2010b) :

- To achieve maturity level 2, all process areas assigned to maturity level 2 must achieve capability level 2 or 3.
- To achieve maturity level 3, all process areas assigned to maturity levels 2 and 3 must achieve capability level 3.
- To achieve maturity level 4, all process areas assigned to maturity levels 2, 3, and 4 must achieve capability level 3.
- To achieve maturity level 5, all process areas must achieve capability level 3.

3.4 Applying the CMMI

CMMI Product Suite's main objective is to improve quality of processes, reduce costs and optimize schedules in an organization. However, the CMMI Framework provides you with tools to calculate and figure out how good their process improvement program is working. Existence of such tools, easiness of use, compatibility and adaptability to business goals of an organization might be some reasons to help top management decide on choosing CMMI for their organization's process improvement work, but top management normally wants to see more. Both Gibson and Ahren emphasize on the importance of having top managements support on running a process improvement initiative in their studies. (Gibson et al. 2006; Ahern et al. 2008)

They also suggest ways on how to draw the attention of top management to the value of such initiative. Normally top management and decision makers look for results and results have to be presented in terms of numbers and in some cases those

numbers should be monetary representations. One way for showing results is to look up case-study reports of companies or research works of scientists, but the CMMI Institute's website also shows recent results and publishes reports on companies having applied CMMI for their process improvement movements. (Gibson et al. 2006; Ahern et al. 2008; Chrissis et al. 2011). For seeing the most recent results please refer to the CMMI Institutes website, which is an entrusted partner of the SEI using the following link.*

Commitment and involvement of the top management requires dedication and involvement, however, this should not over look the participation of other stakeholders, since they are also involved and part of the whole process improvement work. They can be also good sources of contribution at different stages. Once everyone from the organization is in the picture and it is decided to use CMMI for the process improvement, Chrississ et.al in their book CMMI for Development: Guidelines for Process Improvement, suggest use of a model called IDEAL (Initiating, Diagnosing, Establishing, Acting and Learning), which is a model suggested by McFeeley. (McFeeley 1996) McFeeley's work is a proposal on where to start a process improvement initiative, what aspects to be considered and in his model he emphasizes on training of all the stakeholder at each stage along the way. According to him a better informed and well trained stakeholder could contribute more efficiently in the work progress.

For your process improvement plan it is important to select a part of the organization initially. Choose the part carefully so you can present results faster and it doesn't get too big that would make everyone frustrated a long the way. Next to that select an appropriate model out of the CMMI's Product Suit that matches your needs properly, but despite that you should use your own professional judgement while adopting the work. Finally, choose the representation that fits best to your needs and that you would have sufficient resources for adopting that representation. However, keep in mind that is always possible to apply the "Equivalent Staging" process once you choose one representation and later decide to switch to another representation. The only critical point one needs to consider is the correlation and inter depen-

*https://cmmiinstitute.com/resources or https://cmmiinstitute.com/who-uses-cmmi [Both Links Last Accessed: 12.Oct.2024 01:05]

dency of processes that are selected for the improvement work. As it is also discussed later in this section, once the process improvement activities have reached a certain part, we need to consider selection of the right appraisal method to be able to evaluate and calculate our process improvement progress. (CMMI 2010b)

3.4.1 Appraisals

Assessing the status of a work, project or product development process is a common activity among all organizations, even in personal life we think back and check and asses our achievements. Appraisals allow us to determine where we are and then set a goal for further progress. Appraisal in CMMI is a way of assessment for process improvement work that an organization has undertaken. They are also used to confirm reaching capability or maturity levels as well. There are two approaches available for appraisal teams to work with CMMI for the assessment of process improvement. (Chrissis et al. 2011; CMMI 2010b)

- Standard CMMI Appraisal Method for Process Improvement (SCAMPI) (SCAMPI 2011b)
- Appraisal Requirements for CMMI (ARC) (SCAMPI 2011a)

Appraisal Requirements for CMMI (ARC) is a document that "describes the requirements for several types of appraisals. A full bench-marking appraisal is defined as a *Class A* appraisal method. Less formal methods are defined as *Class B* or *Class C* methods."(Chrissis et al. 2011; CMMI 2010b)
The ARC document allows the appraisal teams or parties to decide on which particular appraisal method (i.e. ARC Class A, B, or C appraisal method) to use and that decision often is based on the sets of ARC requirements that the method developer addressed when designing the method. (SCAMPI 2011a) There are several factors involved in which ARC class to be used. "Sometimes self assessments, initial appraisals, quick-look or mini appraisals, or external appraisals are appropriate; at other times a formal bench-marking appraisal is appropriate." (Chrissis et al. 2011; CMMI 2010b)
"The SCAMPI A appraisal method is generally the accepted method used for conducting ARC Class A appraisals using CMMI models. The *SCAMPI A Method*

Definition Document (MDD) defines rules for ensuring the consistency of SCAMPI A appraisal ratings." (SCAMPI 2011b; Chrissis et al. 2011; CMMI 2010b) Class A, B and C appraisal methods form the SCAMPI family of appraisals. However, the SCAMPI A appraisal method is the officially recognized method. This method is the only method in this family that present benchmark quality ratings. The other two classes can present results in a less formal way but still could be useful to the organization to figure out where do the improvement possibilities are laying. (Chrissis et al. 2011; CMMI 2010b)

When it comes to choosing appraisal methods we need to consider a number of factors. The CMMI model in use and to see which parts of the organization are we considering to appraise. The scope could be limited to one organizational unit, a process area that has been worked up with consideration of the CMMI and whether we want to appraise a maturity level or a capability level. Once we confirm what is to be appraised, comes the question of which appraisal method to be used as well as who is leading the team and who are conducting the real appraisal work. It is important to know who you are dealing with and asking questions while conducting the appraisal and not to forget the time spent and other possible constraints that could show up during the appraisal process like lack of or decrease of interest of stakeholders to cooperate with the appraisal team (Chrissis et al. 2011; CMMI 2010b).
"The SCAMPI MDD * allows the selection of predefined options for use in an appraisal. These appraisal options are designed to help organizations align CMMI with their business needs and objectives. CMMI appraisal plans and results should always include a description of the appraisal options, model scope, and organizational scope selected. This documentation confirms whether an appraisal meets the requirements for bench-marking."(Chrissis et al. 2011; CMMI 2010b)

3.5 Different Adaptations of CMMI

In the following sections and sub sections various adaptation of CMMI are introduced and former research in this area is presented. CMMI has opened its way fairly quick and more companies and organizations around the world are trying to adopt CMMI and improve their processes every day. The SEI of Carnegie Mellon tries to

*SCAMPI Method Definition Document

hold on to steering the CMMI development and updates, however, different industries have tried to use one of the models of CMMI product suit for their process improvement initiatives so far. The CMMI Product Suit helps organizations with finding and setting a target and goal to be improved. However, often discussions of "how" to improve are missing; thus some people try meshing up CMMI with Agility or ISO Standards and make a new adaptation of CMMI. They use CMMI to find out what to be improved and use some other methods next to CMMI as an answer to how to improve them. This merely depends on the management choice.

As in June 2016, a total of 2,195 companies, including organizations and government in different industries were forecast to appraise for the first time or reappraise and use CMMI for their process improvement effort (Institute 2016a). They reached levels 2, 3 or some even 5, depending on the approach they chose (Institute 2016a). This forecast reached 2,154* by the end of 2016 (Institute 2017a). The set of various industries are Aviation, Defense & Space, Government, Information Technology and Services, Insurance, Management Consulting, Oil and Energy, Outsourcing categories. These have managed to either apply and achieve a level in CMMI or have considered CMMI for their process improvement initiative in 2016 (Institute 2016a;c). Various scientists and researchers have tried using CMMI in different working environments and use the tools available in this product suit to benefit others and have approached various interesting topics with the CMMI mindset. HAN and FANG from North China University of Technology have tried using CMMI to implement in software management process (Bing and Yinglan 2012), for instance. They claim the CMMI architecture can bring scientific management to project management. They have tried to implement CMMI for the improvement of software management processes. They conclude their work with each project needing its own unique mode and flow of management and they tried to use the idea of CMMI for modeling different project flows (Bing and Yinglan 2012).

Li Jing (2007), of Shanghai Jiao Tong University, argues for the use of CMMI in innovation management, being useful and beneficial to small sized companies. Although he finds the lack of interest to the adaption of CMMI in the Chinese soft-

*Please visit the following link to view the most updated Published Appraisal Results -> https://pars.cmmiinstitute.com/ [Last Accessed: 04.Oct.2024 22:08]

ware industry frustrating and slow, he proves CMMI can be of great help to specially small sized companies such as the ABC Software Company in Shanghai, China (Jing 2007).

With different quality improvement models and industries, it often comes to a point where industries have their own industry-related and accepted standards. Then again a new challenge opens up for managing and finding ways to translate these various methods to one another. As an example one could point to the joint work of Vanamali and colleagues (Vanamali et al. 2008) which tries to break the ice between the two industry-based process assessment and improvement methods, yet different; the CMMI and Automotive SPICE*. SPICE being an automotive industry process assessment and improvement accepted method is often required by several automobile factories from companies that supply them with software systems. This leaves the suppliers, who use CMMI for their process assessment and improvement, with a challenge. However, (Vanamali et al. 2008), tries to point out the challenge, and sketch a way to meet this gap and translate the two industry standards to one another.

Another example is Sabar's master thesis (2011) that is a thorough inspection of CMMI, SPICE and Automotive SPICE in which he tries to show the similarities and differences of the methods and where they can meet up (Sabar 2011).

Wagenstein tried introducing the usage of a Capability Maturity Model for training and education. In his work, he understands training as a *process* and the result of the training, which normally should yield to better competent employees as a *product* (Wagenstein 2006). He emphasizes that the way a training program is delivered to trainees is equally as important as the contents of the training program. His work concentrates on training programs with their target participants being company, factory or organization employees. Wagenstein (2006) believes with fit and competent employees who have received a competent and job related training that is shaped around a CMM based model, the employee can perform better in his working environment and thus present better results as well. In his proposed model, (Wagenstein 2006) puts learning as an "ecosystem" that affects all aspects of a company's busi-

*Automotive SPICE® is a registered trademark of the Verband der Automobilindustrie e.V. (VDA) (SIG 2010)

ness. He puts strong belief on a CMM based education and training model because according to him CMM provides precise methods to evaluate and assess the usefulness of the training in terms of metrics which he considers is a language for higher management in an organization. (Wagenstein 2006) calls his model TEMMPO - Training & Education Maturity Model in Project-Based Organizations, as his model concentrates on education and training of employees who work on a project within the organization.

Another attempt of customizing a capability maturity model has been undergone by (Chen et al. 2011) from Taiwan National and Chang-Gung universities. Their focus was on developing a CMM/CMMI based model that would focus on teachers improvement of teaching quality and thus called their model a Teaching Capability Maturity Model (T-CMM). (Chen et al. 2011) explain their approach to examining the applicability of CMM/CMMI to teaching quality in higher education. They believe, ”teaching quality should comprehensively cover the processes of a teacher from planning a course, instructing and monitoring the course, as well as the conveyance of lessons learned from this course over to the next session (Chen et al. 2011).” Their proposal in building a T-CMM is to focus on the teacher and not the organization. As a result, they believe the concept of CMM/CMMI as per its structure and design should be useful to help sustain teaching quality and build a T-CMM (Chen et al. 2011).

(Baig et al. 2007) from the National University of Computer and Emerging Sciences in Lahore, Pakistan have introduced a concept of maturity model for Higher Education. Their work is mostly based on CMM with some hints of CMMI and People CMM also being used. Naming their work as Educational CMM, they believe their model improves ”key education processes”, having a ”mature degree program” where ”faculty and student performance can be continuously measured and improved” and such a model would help a ”university administration in making better strategic plans” (Baig et al. 2007). Baig et al. (2007) focus on the translation of basic process areas of CMM into their proposed E-CMM. They believe, since education sector functions different from that of other businesses, one should set up a unique terminology that fits the education system. Their work counts out the challenges and difficulties they have faced on their way to achieving their goal, but they do not

mention whether they chose a single case university or a whole education system on a national level as their working target (Baig et al. 2007).

Duarte and Martins (2011;2014) take higher education institutions as a complex organizational structure where processes are channeled in two-forms of teacher-centric and organization-centric. The teacher-centric processes are labeled as independent and individual self-organized entity. The organization-centric processes labeled as a central body of power steering the organization (Duarte and Martins 2011; 2014). This way of thinking allows one to consider different perspectives while dealing with organizations. Duarte and Martin study plan focuses on CMMI based models. In their study, they use SEI's CMMI, the United States Federal Aviation Agency (FAA) Capability Maturity Model as well as the Business Process Maturity Model to argue for the use of such models in organizations such as higher education. Furthermore, they investigate Educational Maturity Models, compare them, point out the weakness and strength of those models, mostly in comparison to their proposed model, which is supposed to be targeting different parts of a higher educational institution all together, rather than focusing on one aspect of an educational institution (Duarte and Martins 2011; 2014). Their work being the most recent in the direction of CMMI based higher education institution model is still a work in progress as the time of this writing.

Over the years different scientists have tried to approach various business areas and have attempted at proposing or developing a CMM or CMMI based process improvement model. As some examples one could point to (Martin et al. 2004) who work on improving communication between the IT Department and the rest of the organization and called it as Relationship Management Maturity Model (Martin et al. 2004).

Williams (2008a;b) proposed the application of CMM to medical security where he targets process improvement environment for offering better and secure medical services. Chen et al. (2006), focused on developing E-Business CMM as a tool for organizations to improve their already running e-business or who want to launch an e-business environment. The Financial Management Capability Model, is a maturity model developed by Office of Auditor General of Canada for auditing and determining financial management requirements of its operations (Auditor General

2014).

Sen et al. (2012) tried applying CMM to Data Warehousing as a way to avoid failing businesses that invest in data warehousing. Ling et al. (2012) introduced a model for curriculum design, again touching another sensitive and yet important aspect of education system. Quaigrain and Issa (2015) worked on a maturity model that would target the construction engineering business area. They argue such a model could help construction businesses with disability management more easily and efficiently.

Neuhausuer (2004); Neuhauser (2005) introduced a maturity based model for the development of online course platforms and still considered and focused on the technological aspect of educational institutions in his work. Lutteroth et al. (2007) focused on a model that allows its users rate educational organizations according to their competence and ability of teaching. Their model focuses on teaching quality in computer science.

3.6 Summary

Chapter (3) presented the literature review and provide background information about different approaches to quality improvement. In order to achieve this goal it is key to understand the stakes involved in running the process and having in mind that every process needs to be optimized in order to produce better results. That is a variety of process improvement and quality assurance methods and tools are introduced to prepare readers for the coming chapters.

Offering quality services or products to customers is every organization's optimum goal. On the one hand, reaching such a goal extensively relies on well controlled process execution practices. On the other hand, organizations can save a lot of time, cost and energy of their employees and thus maximize their profit margin, if the organizational processes are well-arranged and well-organized.

Further more the chapter discusses other initiatives and standards for process improvement and gives readers a more detailed insight into the current and historical stand of those standards. The ending section of the chapter is to give readers a more detailed insight into the CMMI which is used as basis for the work in hand.

The CMMI Product Suite offers a variety of best practices used to identify process areas within organizations. The models in this product suite identify the relevant process areas. The point missing in CMMI Product Suite in general is how-to apply it to different organization structures. The application of this model is a necessary initiative to find out ways to formulate an answer to the missing how to question. CMMI has already solved the problem of what to be improved. Another big challenge for every how to seeker of CMMI Product Suite is the diversity of organizations in terms of size, nature, culture and etc.

Universities have their own complex structure. This level of organizational complexity requires a thorough understanding of their political, symbolic, structural and human resource frames and that is why they are often found as autonomous bodies working all on their own (Duarte and Martins 2011; 2014; Schwalbe 2013). Universities' autonomy is not applicable to every culture as universities in countries like Afghanistan depend on a central body, i.e. the MoHE, that governs and controls everything within a university. A subset of this complex structure is faculties that categorize and offer certain fields of study (MoHE 2015a).

4

Methodology and Data Collection

Chapter 4 presents the data collection approach and methodology, including challenges for the author. Section 4.1 explains the type of methodologies used to compile this research. The focus was to do a qualitative research for various reason details of which will follow up in the coming sections, but nature of the study, which encompassed a broader scope to cover, lack of well structured documentations to evaluate the grounds in terms of numbers and to give participants the freedom to express their opinion openly were a few of the main reasons. Section 4.2 describes the goal of the questionnaire, questions used to acquire opinion of participants, and the reasons this medium was used in approaching participants. In the follow up subsection readers will be introduced to the participants selection and tools that were used to conduct and analyze this research. In the Section 4.3 readers will get a detailed grasp of the setup where this work will be conducted. As readers already have an understanding of how organizational bodies function in Afghanistan from Chapter 2 sections 2.3 - 2.4, here they would be introduced to the details of computer science faculty, the main case study. The Computer Science Faculty of Herat University has been selected as the setup for the study, due the fact that the author of the work at hand used to be a member and had direct access to the limited resources, and yet it

can be still used as a representation model, since the organizational structure of faculties around the country are all the same and vary in small details such number or type of major of studies that would be offered through the departments. The details reflected in this section are important to the goals of the study. The research limitation, challenges and problems are discussed in Section 4.4 and the chapter ends with a summary at the end.

4.1 Methodology

As earlier discussed in chapter (3), the CMMI model comes in two representations, i.e. the Continues & and the Staged, both of which follow a similar path to process improvement. However, the important aspect that can immediately be noticed in both approaches is that the first three levels dealing with quality improvement mechanisms are using mostly qualitative approaches to establish the right basis for the quality improvement initiative of any organization. The quantitative approach comes only in the later levels once the foundation is well laid and the process improvement initiative has reached a certain stability level.
Being inspired by this arrangement of the CMMI and knowing the setup of the case study, i.e. the Faculty of Computer Science at Herat University, its situation, its organizational structure as well as the socio-economic barriers, a qualitative research method is chosen as the basis for the study at hand.
There are three core qualitative concepts that can be seen in any qualitative research work, namely self-reflexivity, context and thick description (Tracy 2013). Tracy (2013) puts self-reflexivity as a source that affects the research subject based on the researcher's past experience, knowledge and demographic understanding of the subject and its surrounding. Therefore, due to the lack of good and well structured documentation of processes, big parts of identifying the process areas of the present study are based on a self-reflexivity of the author's previous working experience in the field which is also backed up with findings of the questionnaires. In some parts the experience gained while working in the IT education institution at hand has been reflected and meshes with the participant observation method as well (Bernard et al. 2017; Tracy 2013). The past working experience of the author has allowed him to observe people

who are in charge of tasks within the Computer Science Faculty and the author has noted how different a task can be carried out by two different people. The individual taste in choosing the manner to run and execute processes and — due to the lack of existing proper complete processes or documentation — can be seen quite often in such setups.

Furthermore, in many parts of the work, bricolage and the funnel metaphor (Tracy 2013) approach to conducting and completing this work is used. Bricolage is ”a pieced together set of representations that is fitted to the specifics of a complex situation (Denzin & Lincoln, 2005 in Tracy (2013))”. First level in both ”Continues” and ”Staged” approaches of the CMMI states and considers everything to be in an incomplete state, such is the reality of the present study. All processes are in place, but they are either not working together or everyone tries to apply their own taste in running the process. To gather the information on processes and identify process areas and bring them together for the CMMI adaptability, a method such as Bricolage, allows the author to piece up the processes and entities together. Likewise as in the funnel metaphor approach, it had to start broad to get into the topic and also used the same approach in shaping the written information in this dissertation. Similarly, metaphor approach helped the author shape a broad image of this work to the audience that may not have a good acquaintance with the case study.

The work at hand targets an institution - Faculty of Computer Science and has used it as the research setup. Like every institution there are several factors involved and in this case individuals with various tastes of running the institution was a hard factor in letting the work get shaped scientifically. Thus the author got to benefit from Giddens' structuration theory. The focus of this theory is to point out the relationship between individuals and institutions (Tracy 2013). This particular theory drew the attention more specifically because of its main focus on creation ways of cultures, organizations and social systems through people. The duality of structure being the key part of this theory was of specific interest to the author. Duality of Structure ”refers to the idea that rules, policies, and structures are only made ”valid” when individuals follow them and make decisions based on them” (Tracy 2013).

4.2 Questionnaire

Questionnaires as described by Curtis et al. (2014) were used for the purpose of gathering data, using online data collection tools (Olsen 2012). Google Forms online service was chosen for its easy reach and distribution as well as the assembly, construction of charts and data analysis. Since participants are mostly working as lecturers, deans, researcher and IT Specialists and are used to working with this online platform for their own research purposes, therefore, this online service was used to prepare the questionnaires and collect data. Participants were chosen according to the following criteria: They had to be members of computer science faculties of government based universities actively working or have worked as lecturer, dean or as an organizational stuff member within those faculties. Emails of faculty members who are working at different computer science faculties around Afghanistan were collected through direct connections of the author to some of the faculty members and then they were contacted through the platform with a link to the questionnaire.

Though a higher percentage of participation was expected, 44 per cent of those contacted provided their opinion and shared their experience which will be discussed in the following chapter in further details.

To prepare the grounds for data collection, the questionnaire was made using the Google Form services. Using the convenience, speed and reach of email, the target audience could be reached (Olsen 2012). Participation in this survey was naturally open as well as voluntarily and users consent in being anonymously or openly narrated was taken into consideration. The contacted participants were encouraged to distribute the questionnaire's link to other colleagues who could have been interested to take part in the survey.

The questionnaire is designed to collect opinion of experts, faculty and stuff members of computer science faculties around the country for a need to a process improvement initiative as well as to identify parts that could require improvement. The overall improvement of the faculty in both educational and managerial parts will lead the faculty to offer better IT Education to current and future students who are willing to pursue their educational carrier in computer science.

The questionnaire was structured into multiple parts and the questions had either

pre coded answers to select from or qualitative open comment (Olsen 2012) areas were provided to let the participants provide answers with their own choice of words. Since participants of this data collection procedure are people with Informatics and Computer Science studies background, the English language was chosen as the communication means to participate in the survey.

The goal of the qualitative questionnaire was to collect information on the current status of their respective organizations in terms of defined procedures, process areas and to see what already exists and if participants would agree to the lack of predefined established processes.

The questionnaire was designed to collect opinions of Computer Science lecturers as well as organizational staff members on a process improvement initiative as well as on parts that require improvement. The participants were introduced to the questionnaire; the aim of the survey was communicated and the anonymity of participation was taken into consideration. Provision of personal data was optional and no names were quoted. Only four participants have attended with a pseudonym or left the optional name field blank, the rest provided their real personal data. This field was meant to contact people for follow up communication or if their answers to the open-questions required further explanations.

It was made clear to the participants that their participation provides a general picture for an overall improvement of the faculty in both educational and managerial parts, that then leads the faculty offering a better IT Education to current and future students who are willing to pursue their educational carrier in computer science at Afghan universities.

In total 50 lecturers from different universities were sent participation invitations. They are all either academic faculty members or working at an administrative role in a department or faculty of computer science. The participation took place over an online survey form that was prepared using the Google Forms service. The questions were featured as mandatory and optional to answer. The answers were categorized as pre-coded and open answer with short and long text possibilities. After almost five months of waiting time, multiple times of sending reminder emails and making personal calls and asking for favors to further distribute the questionnaires, 22 participants agreed and attempted to attend the survey and submit their opinion.

The questionnaire design was mainly inspired by the CMMI model on its own, to help understand the current situation and to find out whether processes that could be identified by the CMMI model is present or possible to draw a matching line. For this reason the questionnaire was divided into seven parts and the questions related to each other were put in each part. A blank copy of the questionnaire is exhibited in Appendix D. The first part is mainly organizational part, to gain access to the participants personal data and their consent on being actively quoted and contacted.

The participants of this survey had a great impact and knowing their perspectives formed the author's approach to conducting this work. The author could narrow down his final approach to those process areas that needed the most attention and in some cases almost all participants agreed on having such a reference model and that it could impact improvement very highly. The following chart gives a clear image of the number of participants coming from various universities:

Number of Participants per University

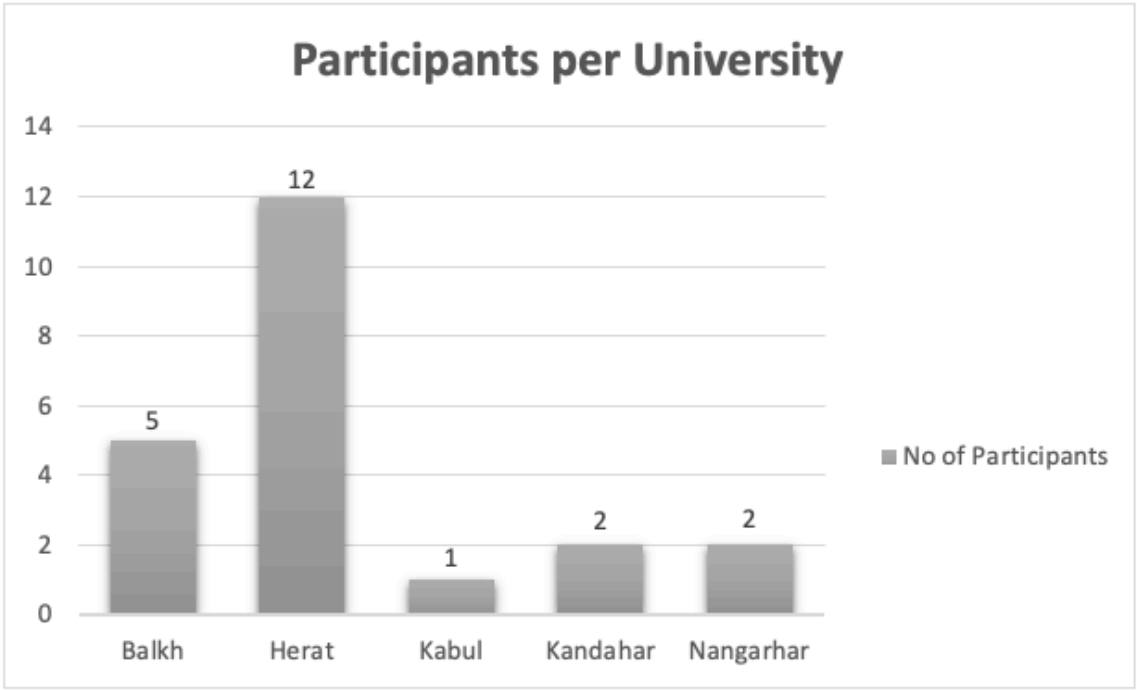

Figure 4.1: Participants are Computer Science faculty members of respective universities

The work experience of participants in computer science faculties is important for contribution of participants would mean they have already dealt with pros and cons of working at the computer science faculty. They had dealt with problems in one way or another and found a way to sort out those problems. The following chart

(Figure 4.2) depicts the working experience of participants. An adequate number of the participants have earned their experience and hence their feedback is of great value as they know difficulties of the situation and have been dealing with those kind of shortages quite often themselves. It shows a majority of them have already gathered working experience in the field and have made their way dealing with those challenges. It is also worth mentioning that for a field of study so young, the low number of years of experience is not a big surprise. Kabul university being the oldest University with a Department of Computer Science has definitely more experienced members, but unfortunately either the invitation to participation in the survey never made it to the Email Inboxes of those experienced colleagues or there were no interest in taking part in the survey.

Working Experience of Participants

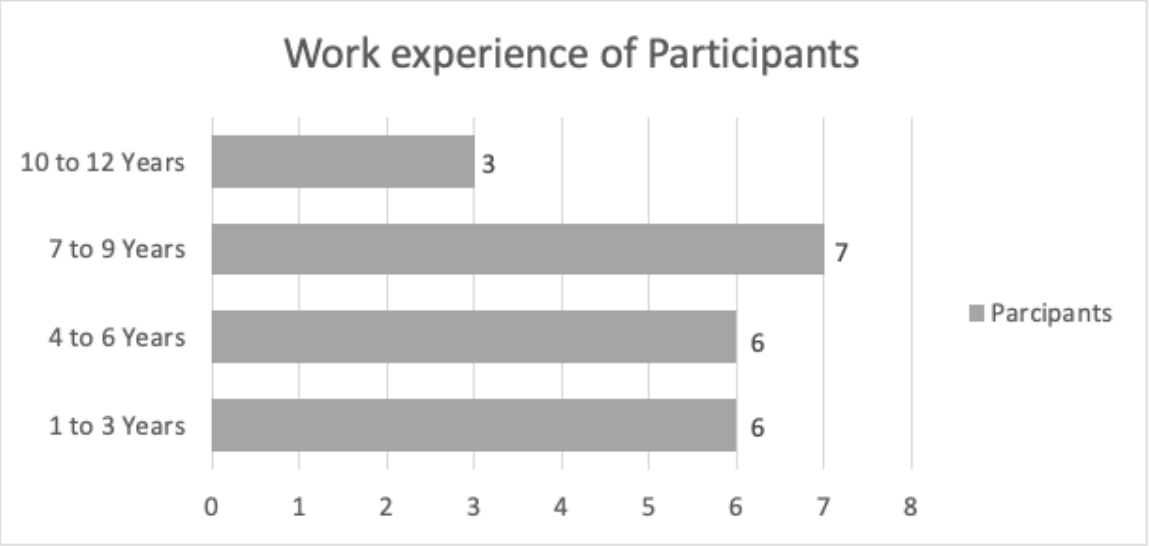

Figure 4.2: Employment years in one of the Faculties of Computer Science

Second category of the questions deal with identification of the requirements needed in the faculty. The questions in this category try to investigate the nature of requirement handling at the very educational institution the participant is working at. Here the goal was to see if the requirement gathering and maintenance process exists or there is a need for a standard tool to improve and to support it.
The third category of the questions digs into the information surrounding the Syllabi and syllabi management system. A syllabus and its management is one of the most difficult and challenging tasks of any educational institution. Since the study

material, their requirement, resources that they need are all covered by this part and keeping it up-to-date is similarly time consuming and challenging. The set of questions in this category are helping present a picture of how the participant deals with the topic and what aspects s/he finds important.

The production time of an educational institution is divided into semesters. In case of this study a semester's duration is defined as 16 weeks of continual teaching and exams period and each educational year is consisted of two semesters. The execution of the semesters through out the year follows the cold and warm areas of the country and is compacted together so that the very cold or very hot season the students get their time off. Considering all the variables involved in executing a semester at an Afghan educational institution, the fourth category of questions tries to find out the manner a semester is planned, executed and maintained. Participants are explicitly asked to present how they see such activities within a semester and how does their organization go about it.

Quality assurance being one of the important topics and also one of the new initiatives of MoHE for all universities and faculties was the target of the fifth category of the questions. The questions in this category try to find out the participant's understanding towards the QA process on its own, and how is it implemented in their institution already. Here the participants are given the opportunity to discuss and explain their own observation of the process and share their opinion on what does it mean to them and how do they evaluate its importance.

The sixth category of the questionnaire was of specific interest to the author for the nature of the questions in this category gave the participants the possibility of identifying important processes and process areas that needs to be improved, handled and/or changed. These questions are helping the participants to think about their organization and identify points that need improvement and further examination. The questions in this category are mostly open end questions and let the participant provide their input to the topic.

The final category of questions are trying to figure out whether organizational training exists and to see what type of trainings are expected by the participants. These questions try to narrow down if participants see the need to further training for the faculty members within the educational institution as something important

and relevant or if it could be left out.

4.3 The Setting

In this section readers will get a detailed picture of the setup where this work will be conducted. The historical, functional and organizational structure of education system in Afghanistan were explained in Chapter 2. In the study at hand computer science faculty is chosen as an educational body that is in charge of IT Education, offering IT related studies within the functional framework of a university. In the following subsections the details about Computer Science Faculty of Herat University has been presented so the readers get an understanding of the structures which is then also used as the setup for the study. Direct access of the author to the resources of the faculty is the reason that these details are presented. However, it is just a representative approach, representing this one particular entity, but it can be still used and adapted in other faculties around the country. The organizational structure of all computer science faculties around the country are the same and vary in small details such as number of departments or type of major of studies that would be offered by the departments. The details reflected in the following section are important to the goals of the study, since the participants of the questionnaires are all faculty members of computer science faculties around the country. That is why their input is a reflection of their experience and understanding of the system that will be discussed and analyzed with further details in Chapter 5.

4.3.1 The Faculty of Computer Science

The establishment of the Computer Science Faculty at Herat University has a long turbulent history. It was originally part of another semi-private university called the Islamic University of Science and Technology, formerly founded in Herat Province in 1992 (Mahr et al. 2006). The university was ordered to be closed down after the assessment of its performance by former Higher Education Minister, Dr. Fayez (Mahr et al. 2006). Lack of financial budgets of the university as well as certain political reasons ended this universities life in the spring of 2004.
However, the MoHE took responsibility of over 250 students of the faculty at that

time and started taking action to integrate Computer Science studies in the administrative framework of Herat University. Herat University was not ready to host these students both in terms of physical location as well as man power to take over the teachings. In the fall of the same year, Ministry of Higher Education contacted DAAD (German Academic Exchange Service) and the Technical University of Berlin for assistance. Dr. Nazir Peroz, head of ZiiK (Zentrum für internationale und interkulturelle Kommunikation) of TU Berlin agreed to send a group of teaching staff to Herat University (Mahr et al. 2006). The first German three-persons team consisted of Alexandra Balschun, Jan Suhr and Sebastian Guenther, back then graduating students of TU Berlin. (Mahr et al. 2006). They started teaching and supporting the 250 students of Computer Science with Information Technology lectures. The education and development thirsty students also volunteered to help the German teachers with the development process of the Computer Science Faculty. This whole process took around three years until finally, Faculty of Computer Science was officially recognized as part of Herat University in 2007.*

Despite the troubled beginning, after having earned the cooperation and support of TU Berlin, the Faculty of Computer Science has managed to establish itself well. As of the time of writing this chapter, the faculty has three active departments, 17 academic members, 4 administrative employees, a volunteer Network Administrations team being supervised by one of the academic members, 4 PC-Pools and well equipped updated library. Table (4.1) shows number of students being graduated from this faculty since establishment until 2019.

No.	Year	Female	Male	Total (HU 2015c)
1	2006	0	8	8
2	2007	13	29	42
3	2008	23	41	64
4	2009	7	32	39
5	2010	15	37	52

*There is a difference of opinion in the year of establishment, some sources consider 2004 as the establishment year of this faculty, whereas others including the author, consider MoHE's official recognition as the starting point of this faculty's activity within Herat University. Their official logo and stamp also bears 2007 as the year of establishment.

6	2011	25	30	55
7	2012	15	53	68
8	2013	11	53	64
9	2014	16	66	82
10	2015	33	65	98
11	2016	—	—	118
12	2017	—	—	141
13	2018	—	—	106
14	2019	—	—	118
Total		158	409	567

Table 4.1: Number of Graduated Students of Computer Science until 2019

Figure 4.3 shows the organizational chart of the Computer Science Faculty. The organization structure of the faculty is similar to that of the university on its own or the ministry, just in a smaller scale. In total, activities of the faculty are structured and divided into three parts i.e. departments, students affairs and working counsels. The departments and students affairs have an administrative existence. They are defined and approved by the laws and regulations and the administrative structure of the university. However, the working counsels are supporting entities formed by the faculty members to carry out certain grouped tasks within the faculty. Their existence is approved by law and regulations and their actions have legal consequences and support, but they don't require an administrative position; thus, in the chart they are shown with doted lines.

Each department's tasks, goals, activities and responsibilities of the department members are explained in the following sub-sections. The students affairs department's structure, responsibilities and reasons of existence are explained. However, bear in mind that Faculty of Computer Science has 17 teaching staff and 4 administrative employees in total at the moment; this number is a challenge to the growing pace of the faculty as well. To over come this challenge on the day to day basis, one person often carries out multiple roles at the same time. From the very beginning of joining Herat University, this faculty got its academic and partially financial support from

and through the TU Berlin funded by DAAD and the German Foreign Office. Faculty members have received several short term trainings, have attended degree programme at TU Berlin and IT related conferences that was arranged by the TU Berlin since 2004. This cooperation and collaboration has resulted in many fruitful outcomes for the faculty.

Organization Chart of Computer Science Faculty

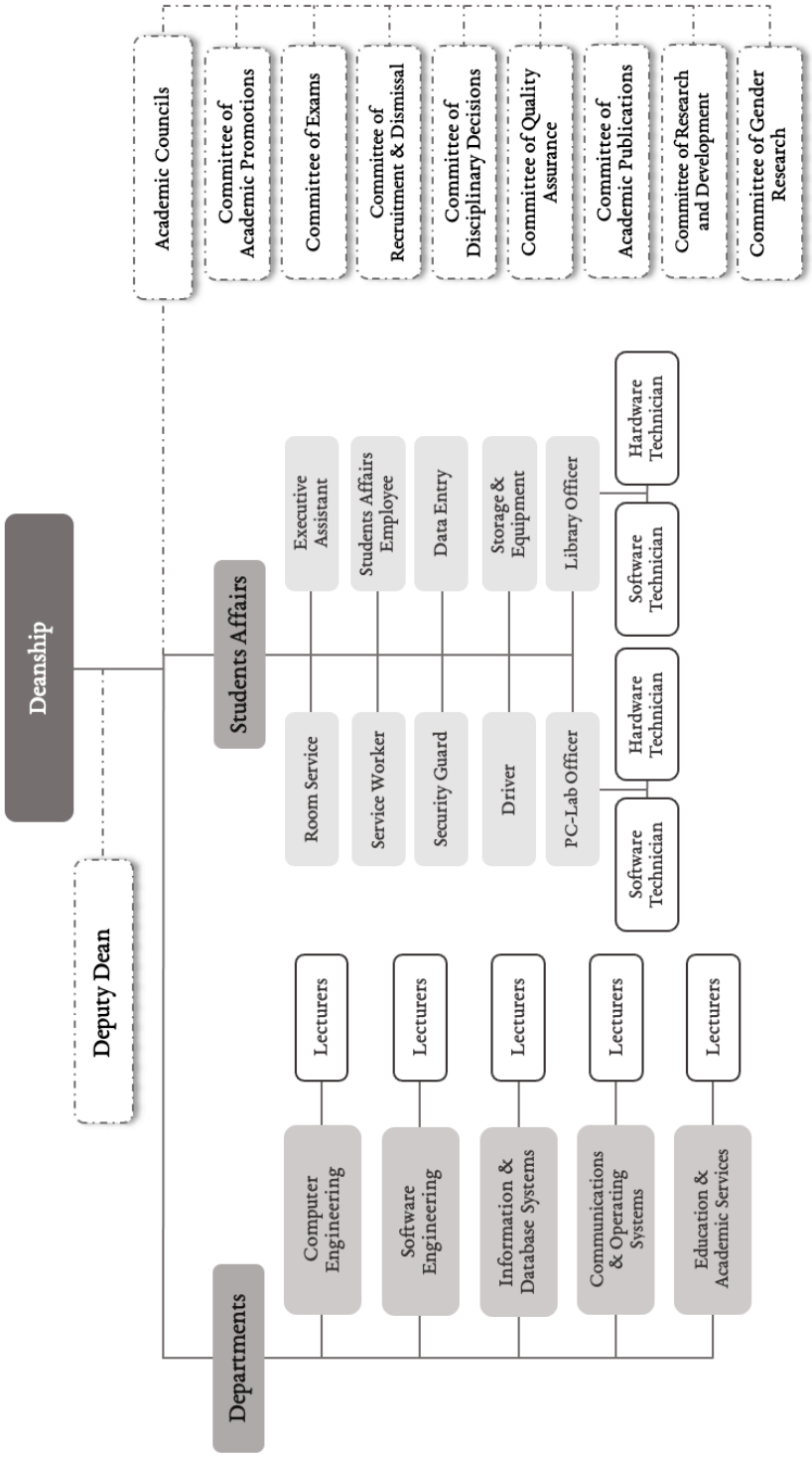

Figure 4.3: The Organizational Chart of Computer Science Faculty

Deanship

The head of the Faculty's administration as well as academic members' position is filled with a Dean who is kept accountable and responsible for everything. The se-

lection process is mostly administered through the general assembly of all faculty members and the nomination of one or two person(s) for the position. Once the person is selected, s/he will be introduced to the university and consequently to the MoHE. Until the final approval of the President of the country, this person is titled as a care-taker or acting dean. Deanship, though in the hierarchy of the administrative system of the ministry is low in the management levels, but is the only position that needs the final approval of the President of the country for someone to be officially appointed and accepted as the Dean.

StudentsÁffairs

This section of the faculty is responsible for dealing with everything that concerns students activities in the faculty. That includes exam records and results, chairs and cleanliness of the faculty. Everything falls under the responsibility of the person in charge of this section. The work load is high and the person in charge often gets help and support from other colleagues and the teaching staff members as well.

Executive Assistant

Receiving, writing, sending and keeping a clear and ordered record of letters is the responsibility of this person. Since the correspondence system in Afghanistan is totally paper-based, s/he must make sure not to lose track of the documents and must be able to retrieve a copy of any previous correspondence easily. Scan copies of the documents are allowed to be communicated over electronic channels lately, but a digital copy does not have the legal authenticity. It is used as an information source to start acting on the content of the documents, but the actual work and response takes place only once the original document has arrived. That's why the person in charge of this position needs to have a great deal of place and a good sorting and searching system to find stuff when needed.

Students' Affairs Employee and Data Entry is a job for two people. The first is responsible for students admission and registration, daily life issues, providing support with hostel and accommodation. The second is responsible for recording students exams results, collecting and registering students data in the legacy paper based book systems currently in use. Ministry of Higher Education has introduced the HEMIS (Higher Education Management Information System), a software system for collecting and recording students exams. However, this software is still in the testing phase

and the traditional paper-based book keeping still has priority over the software system. The Executive Assistant and Students' Affairs officer at Computer Science Faculty of Herat University takes care of all these extra persons' job together at the moment.

Storage & Equipment

The safe storage and maintenance of any piece of equipment be it office furniture, computers, projectors, archived documents or books falls under the responsibility of this person. S/he is responsible to look after all the equipment and should channel the repairing process through the appropriate sections within the university.

Library Officer, Librarian and e-Librarian

are three man's job to deal with keeping the faculty's library open and available for students. They take record of the borrowed books and follow up, should a student return a borrowed book late. However, all these tasks are run by one person at the Computer Science Faculty and the Storage and Equipment manager acts as the librarian too.

Room Service

The responsibility of this person is to keep the faculty's environment clean and to make tea for the administration. S/he also sometimes acts as a post person and brings letters to the appropriate sections within the university.

Service Worker/Gardner and Security Guard

are responsible of taking care of the faculty environment and utilities. Since the University lacks budget for hiring all these people, and the Computer Science Faculty shares a building with Engineering Faculty, thus the Service Worker/Gardner and Security Guard of the Engineering Faculty looks after the Computer Science Faculty's belongings too.

Driver

In the administrative structure of the faculty, a driver is considered. However, there is neither a car nor a driver, since the Computer Science Faculty has more pressing issue such as a building and classrooms for its students. The vacancy remains empty until the faculty has its own vehicle that will be used to transport staff members and lecturers around for off campus official meetings. Until then, all faculty members are responsible for their own transportation.

PC-Lab Officer

Due to financial shortages, the university has never appointed technical staff members to work as the officer and technicians for this section. However, the Computer Science Faculty has come up with a solution. One of the teaching staff members of the faculty takes responsibility and acts as the PC-Lab Officer, where s/he trains a group of volunteer students to work as software and hardware technicians. Every couple of years a different staff member takes over the responsibility and thus the section's services are offered to the students and the faculty without any disruption. This entire team is responsible for the network infrastructure, the PC-Labs, projectors and computer equipment of the faculty and to do the regular maintenance of PCs within the faculty. This team also helps with the practical lessons of first and second semester students in Computer Engineering subject e.g. students, hardware and software related problems.

4.3.2 Departments of the Computer Science Faculty

According to the MoHE laws, the establishment of any faculty is bound to the establishment of at least one department (MoHE 2015a). "Department is the basic academic, teaching, research and administrative unit of a faculty having at least 4 academic members. (Article 2, Paragraph 7)" (MoHE 2015a). Thus considering this law as of 2017, the Faculty of Computer Science has managed to get approval of the MoHE for the establishment of four departments. Three departments are already active and are briefly explained in the following subsections. The establishment of the fourth department i.e. the Department of Computer Engineering - was planed for the academic year 2018. However, this plan has been postponed and instead another Department called Computer Education is established, which is supposed to cover the computer education subjects in other faculties. This department is a service-oriented department and is not graduating any students with a major degree. Every department has a Department Officer, who is an academic member of the faculty, selected among the department members. Department members have to select a new officer every two years or vote for the same officer should they be happy with his/her activities during those two years. The department officer is responsible for all academic and administrative activities of the department members. Assign-

ing subjects, making time tables, observing and evaluating the academic activities of the members, holding regular meetings with the members and attending faculty meetings are part of the responsibilities of the department officer. The department meeting minutes are written down in a book by one of the members who writes the protocol and which is then signed by all members. Contents and pages of this book cannot be altered or can have extreme legal consequences for the officer.

The enrollment of students in the Faculty of Computer Science solely depend on the results and placements assigned by the Ministry of Higher Education through the general Kankur Exam. Some 150 (HU 2015b) students were roughly enrolled in the faculty during each year between 2012 - 2015. The Bachelor degree study programmes of this faculty is divided into four years, where the first two years are mandatory subjects all students must take; for the last two years, they can choose between subjects offered by one of the three departments. The idea of this division is to give students more focus on a certain list of subjects. Competence and skills that each student develops are clearly described and introduced to students during the first two years and also right before the selection process takes place*. Appendix A shows a more detailed but yet abstract insight into the Bachelor study programmes of Computer Science Faculty.

Software Engineering Department

"The Department of Software Engineering (SE) focuses on the production of software, from the development to operation of software systems and organization and modeling of the associated data structures. Software engineering comprises numerous branches, which together accompany software development. Besides the development operation is also part of software engineering." (Peroz and et.al 2014)
This department mainly teaches an introduction to computer science and offers additional advanced courses to general and specific fields, such as object orientation, aspect orientation, new software development paradigms, model driven software development, formal modeling and analysis of software based systems, quality assurance, testing, software development processes and IT security. Emphasis is put

*As of August 2017, students department and major of study within the Computer Science Faculty is also set by the Kankur Exam's selection procedure. Students study the fundamentals and basics in the first two years and they will focus in one of the three majors that they were picked for at the Kankur Exam in the last two years.

on conveying understanding of basic aspects of modern software engineering with practical examples. Courses, projects and seminars are offered. Students who have completed the 4th semester successfully, can choose these topics as their special field of study (Peroz and et.al 2014).

This department had five members; all of them have obtained a master degree in Informatics from the TU Berlin.

Database and Information Systems Department

"This Department examines the management, effective and efficient processing of large amounts of structured or semi-structured data. The core topic of the department is the usage, structure and implementation of systems that allow management of information. For this purpose the department deals with all aspects of the information life cycle, which includes the fundamental steps of information modeling, information extraction, data cleansing, integration of heterogeneous data sources, efficient query processing and archiving." (Peroz and et.al 2014)

This department offers its students courses including an introduction to databases and their architecture, the relational model, SQL (Structured Query Language), an introduction of the entity relationship model and the normalization theory. The notation in UML class diagrams as well as the advantages and disadvantages of XML models versus relational database models are discussed within different courses that are offered by the department. Further, the evolution of database management systems is reviewed in the courses offered, concurrence, recovery and optimization are introduced, distributed databases are explained and an introduction to object oriented databases and their future is given in form of lectures and practical projects within different courses. All technical content is thought in consideration of the aspects of Afghan culture, meaning that a focus will be put on Unicode an aspects of internationalization in order to cope with database systems in national languages (Peroz and et.al 2014).

This department had seven members and has reached its maximum number at the moment. All members have a Master Degree in Informatics from the TU Berlin. Two of them are PhD Candidates at the TU of Berlin.

Communication and Operating Systems

"The Department of Communication and Operating Systems (examines ques-

tions which are traditionally part of the field of operating systems, but which now, as a consequence of the growing interconnections of systems and applications, have to be seen outside of this context, too. The topics include resource management, scheduling, protection and security, interaction, information processing, directory and refer all services. The applications to be supported range from parallel computing and Internet based client-server systems to mobile and embedded devices" (Peroz and et.al 2014).

The department offers introductory courses and additionally gives advanced course of operating and communication systems, distributed systems, dependability, security, middle-ware, cluster and grid-computing, security and performance evaluation. An emphasis is put on conveying fundamental concepts, method and algorithms that are essential prerequisites for developing complex distributed systems (Peroz and et.al 2014).

A sub-field taught by the Communications and Operating Systems Department is computer networking, which covers all technical and conceptual aspects of interconnecting computer systems over small local area networks (LAN) and large distances in wide area networks (WAN) or the Internet. They include Internet applications such as the World Wide Web, email, Usenet, the principles, modeling and performance of network protocols, wired and wireless network hardware standards, network typologies (ISO/OSI model) and more (Peroz and et.al 2014).

Out of the five members of this department, two had a Master Degree in Informatics from the TU Berlin. Two had started their master studies at the TU Berlin and one has a Bachelor degree in computer science from Herat University.

Computer Engineering Department The Computer Engineering department was accepted in the development plan of Herat University's Computer Science Faculty (2014-15) by the MoHE. The strategic goals of this department were set to educate and train students for the job market in computer hardware applications and troubleshooting. A student choosing to study in this department will have the competence to work in firms that deal with computer hardware, design, production and troubleshooting. Currently, the department is still not accepting students, since, the study programme of the department should go under a thorough revision of peer universities in Kabul as well as the partner university of TU Berlin. Thus the inau-

guration of this department has been postponed to 2018/19. However, the departments establishment is further postponed due to prioritizing the establishment of Computer Education Department, which is not an active department in terms of admitting students but to offer other faculties of Herat University computer education programmes as a service. The establishment of this department was mostly intended to enhance the administration structure and to introduce new vacancies for hiring more new lecturers.

4.4 Limitations and Challenges for the Researcher

Finding suitable documentation in Afghanistan is very difficult. Not much research has been conducted and published in this field that could help one to find reliable and relatable resources. Rules, regulations, guidelines that run, define and form processes within the organizations and are mostly in paper form and not available to public. Although they are meant to be public property, they are often printed in limited numbers; that is why those having access to these documents are very cautious about sharing them. In addition, copies can only be made under certain conditions. There are several initiatives deployed by different ministries and organizations to provide online resources to make digital resource sharing possible. As an example the HEMIS (Higher Education Management Information System) Project of the MoHE should be able to provide the facility to store such public domain documents very easily, but at the moment the focus is on other aspects of the system such as students registrations and exam results and marks.

For some of the questionnaire questions, a text field for answers was given. That led to participants entering the answers in different spellings. As an example for name of the participant's university they had answered with HU, Herat, Herat Univercity, Herat University, which all related to the same university, efficiency of the online tool could not be used that well and a data clean-up using Spreadsheets (Excel and Numbers Apps) before further assessing the data had to be applied. Questions like that should have been formulated with check or radio boxes to collect clean data. Since Informatics is almost taught everywhere in English or at least the teaching material is provided to students in the English language, it was assumed to be easier to

collect the data in English. Some of the questions are answered in short sentences or a few words that make it hard to get a plausible meaning out of them. It is difficult to decide if this was caused by the lack of interest or due to insufficient English competence. Some of the answers lead to the assumption that participants did not understand the questions.

The biggest challenge one could face in general is lack of interest in taking part in surveys and studies. In the academic society of Afghanistan this is very evident. Often, the lack of access to the internet is given as an excuse, but a possible explanation could be over filled schedules of colleagues who were approached to participate.

4.5 Summary

Chapter (4) tackled the approach of the study at hand to find data, the methodologies and the data collection approach for putting this work together. This work enjoys the qualitative data collection approach using questionnaires. The structure of the questionnaire is explained.

Since the study and analysis of process improvement models are applied to the Faculty of Computer Science at Herat University, therefore it was necessary to take readers on board and to prepare them for the following chapters where it would be most specifically talked about processes in this organizational structure.

The setup that considered for the case study under consideration of this work is explained and the grounds for the research questions and theme of the work was paved into. In general this chapter gives readers an image of how the research was planned to be explored and the reasons for choosing the methodologies for conducting the work. In the coming chapter - Chapter 5 - the findings and collected data will be analyzed thoroughly.

5

Data Analysis for Process Improvement

Chapter 5 presents the data analysis of the research work. The collected information through the online survey form have been put together and a thorough analysis of the findings within each category of the questions has been presented. In attempt to address the challenging process improvement initiative, it has to be kept in mind that the case study is a government entity that follows strictly defined rules and regulations of the MoHE.

An organization of any nature is made up of several process areas and processes that define the nature of the organization as the entity in question moves forward to achieve its goals. These processes need to be defined, if not defined already and definitely need to be optimized and improved. Along this progressive path every organization faces, there is no doubt that changes will come and improvement will be needed.

The information gathered through the questionnaire helped the author form a picture on the current situation, how the processes are dealt with, how is the organizational entity at the core of this study — i.e. faculties of computer science — deal with their tasks and reaches its goals. Luckily due to the central government and top-down management system in Afghanistan, the processes are always defined the same and hence feedback of participants from different Afghan universities pictured al-

most similar situation and handling methods.
The participants of this survey had a great impact and knowing their perspectives helped forming the approach to conducting this work. The author could narrow down the final approach to those process areas that needed the most attention and in some cases almost all participants agreed on having such a reference model could impact improvement very highly. The participants were mostly members of the universities and all of them work at the computer science institution that this work attempts to address.
Since the identity of the participants are mandated to be kept secret, - specially after the new political changes in the country -, there won't be any direct quotation from the participants answers. Though some of the participants consented to be quoted directly, but the author decided to unify the approach and annonymize identIties of the participants. However, in most of the analysis part in this chapter the choice of words for the answers are tried to be mixed and combined. It is not clear if it was the participants English skills that yield to different choice of words for answers or they have interpreted the questions somewhat differently. However, in all parts the author has done his best to keep his neutrality in the analysis and provide the best possible course of information to the categories and topics discussed in the following subsections. Questions that deal with similar topic and try to investigate similar issues are put together into categories and thus the analysis of findings are compacted together under each category. Where applicable a direct reference to the question of the questionnaire is also provided, the entire questionnaire is exhibited in Appendix D.

5.1 Requirements

Every faculty has requirements and they are material, resources and tools that help with running a process or set of processes in the faculty. Participants named mostly the following items, physical space for teaching and administrative activities, library and its related resources, PC-Pools, human resources, office stationary and so on. Participants of the survey named a few more requirements that indeed are worth mentioning. Laptops for lecturers, relaxed chairs and furniture, recording equip-

ment for providing course contents digitally, syllabi updating, very high bandwidth Internet connection, hardware maintenance and training labs. A good digital infrastructure with IT Services were also highlighted as important requirements for the faculty.

The faculty has requirements in general and for each semester in particular that needs to be managed systematically. It could save time, processes could run efficiently and help faculties focus on the overall quality and invest time and resources on weaknesses and strengths that could need improvement. The faculty should have a system, an online platform or a tool to use and manage their requirements. At the moment such a system doesn't exist but before the start of the semester a general meeting of all members is conducted and a need assessments is done. A majority of the participants have clearly stated that their faculties do not have such a system in hand whereas some have mentioned usage of software tools like Excel sheets and Moodle partially, focusing on certain activities like students records or as an alternative to lecture management. A few of the participants left the answers blank.

The current approach to measuring and collecting the requirements is described differently, some hold general meetings, some follow the university guidelines and present lists from time to time to the university. No certain way to follow up is documented and they all agree that the current way is not suitable enough to meet the requirement. Though a general meeting is common in all answers that would be doing the requirements gathering, but mostly deans, and administrative affairs officer along side of the department officers have been stated as the person in-charge of requirements development body. Though it might sound conflicting, but due to the top-down management system, it is always the higher ranking member's responsibility to collect faculty members for meetings. The following figure 5.1 gives a reflection of the answer that has been plotted into a chart for a better understanding of the roles. The results of the meetings what ever the content might be will be then again channeled to the top management at the university through them.

Roles in charge of Requirement Development

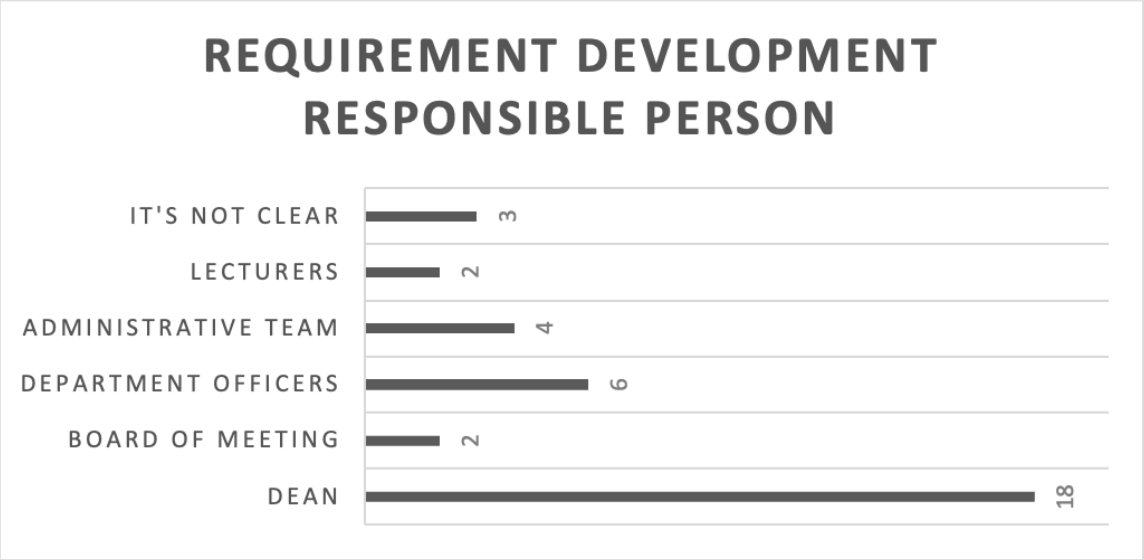

Figure 5.1: Persons in charge of developing requirements

5.2 Study Material

Course syllabi which often are misunderstood and misinterpreted for curriculum (Mohmand 2010) is a core and central pillar for an educational institution. This entity is one of the focal points of the faculty activities at the current state of computer science faculties in Afghanistan. Keeping contents of the syllabi up to date is essential to every field of study and in particular in the field of Computer Science since with the progress of technology and the rapid change of market demands. Therefore, a faculty whose mission is to present competent graduates to the market has to be able to present updated topics and stay not too far behind the changes that happen in today's IT world. Luckily the majority of the participants answers to whether faculty would update the syllabi regularly or not (D - Questions #15) was positive. Updating Syllabi is a time consuming challenging task for the faculties. Considering the Afghan educational institutions structure, it is a positive point to know that the faculties execute such a task on certain intervals. However, the intervals of updates stated differently by the participants. The following plotted chart (Figure 5.2) is to show the intervals stated by the participants.

The participants have mentioned different roles as the responsible person who would have to bring changes to the syllabi. This is another question that should

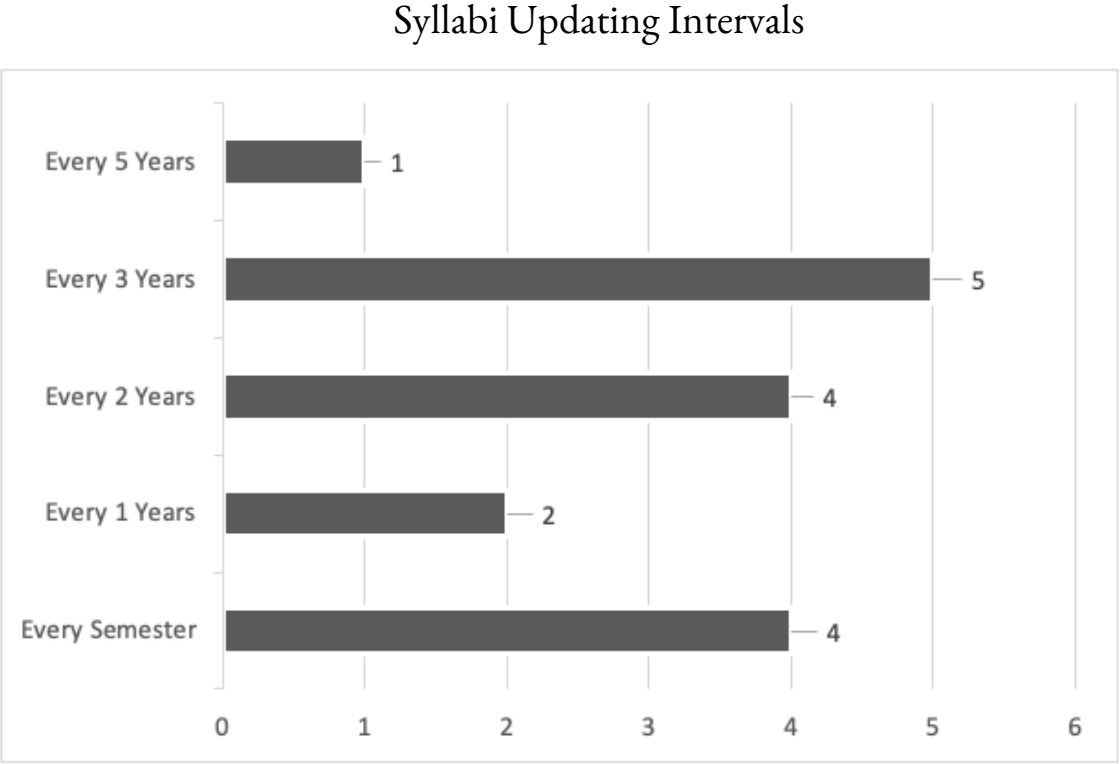

Figure 5.2: Numbers indicate syllabi updating intervals

have been stated as two separate questions and one could get a better angle in analyzing the answers. Though the question is clearly a two part question, but somehow the participants ignored the first part and mostly answered the second part directly. Hence, the variety of answers have made the role of the person involved in updating the syllabi is very vague. From the number of answers that have the words (I, myself, lecturers, department members and department officers) one could still indicate that the faculty members are mainly responsible for the update and development process of the syllabi. Every participant who filled out the questionnaire is a faculty member and lecturer, therefore it is possible to assume lecturers have the direct call in updating the syllabi. The rest of the participants had mentioned other perspectives that could be a result of the interpretation of the question on its own. A couple of the participant mentioned administrative regulations of how the updates are done through a specific task-force, where another pointed the teaching experience as the key to updating syllabi. One of the participants also mentioned unavailability of a coherent system in place, where another had mentioned no update having taken place in the past till then. Having these findings, one could easily indicate that faculty members who also work as lecturers are basically the ones that has

to be involved in the updating process of the syllabi, since they have the expertise, know-how and experience. The MoHE laws, regulations and strategic plans define the necessity of updating syllabi on a regulare base. They also mention that it has to go through a few layers of controlling, with the update initiative starting at the department, controlled by a faculty Syllabus/Curriculum committee with follow up controls at the university and ministry levels.

As the next figure 5.3 shows majority of the participants have mentioned that there were no fixed system to integrate Syllabi changes where one could track the old versions and have a comparison of how it has been developed further. This indicates, although updates are taking place at good enough intervals, but unfortunately a system that would track those changes for monitoring, evaluation and tracking purposes at later stages is missing.

A fixed Syllabi Updatingintegrating System

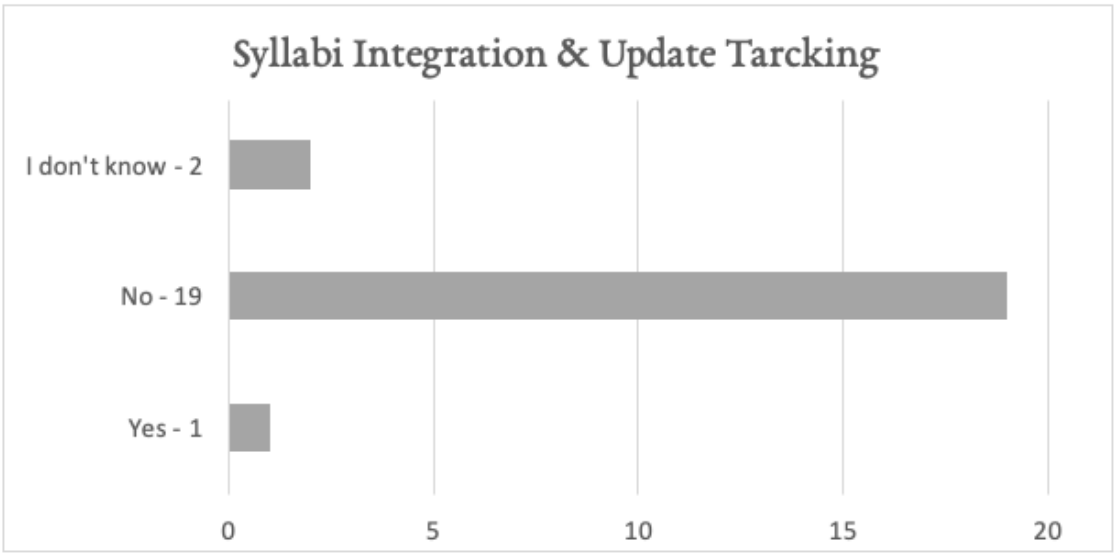

Figure 5.3: Numbers indicate survey participants mentioning lack of a fixed system for tracking syllabi updates

The administrative process of such updates are best practices that makes sure a new change is necessary, scientifically approved and needed for the education of the students. The process starts at its very low level with the faculty members working on it and creating the content. But the long and time consuming follow up levels until the changes are approved is demotivating and by the time the final approval comes from MoHE a couple of semester are gone. Though this long process applies only to major changes, minor changes at the study material level can be approved by

the department and the faculty board and must not go through the long chain of administrative structures.

The participants have expressed different opinions about the control of syllabi contents implementation in the classroom. However more than 70 % of them have answered that there is a controlling mechanism in place. A couple of them didn't know if such a mechanism exists and the rest have indicated that there is no controlling mechanism in place. The following chart reflects these answers.

Controlling Syllabi Implementation

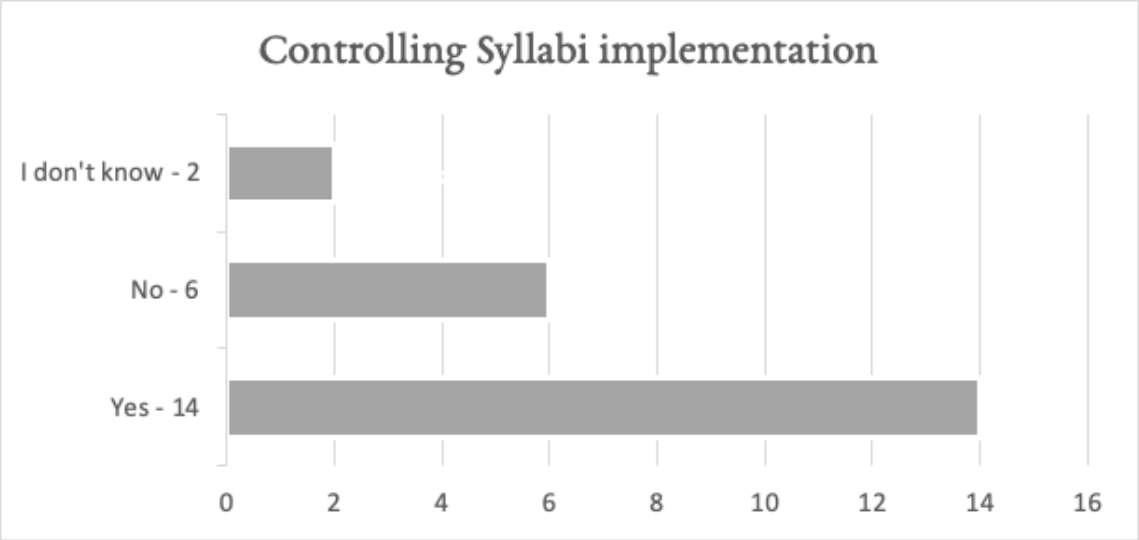

Figure 5.4: Numbers indicate survey participants answers to the existence of a controlling mechanism on syllabi implementation

The MoHE regulations define as part of the job description of the Department Officer that the officer should control the implementation and progress of syllabi content through out the semester. But since such regulations and documentations is not always shared with everyone, therefore the variety of answers reflect the uncertainty of the participants on knowing who should be controlling the implementation progress of the syllabi within a semester. Survey participants have mostly indicated head of the Department, but also at the same time selected other options that were provided as an answer.

The interesting observation comes from the answer to the last two questions where without any exceptions all participants have agreed on the necessity and the implementation of having such a system that would help with controlling, monitoring and evaluation of syllabi updates and implementation. They find a system that would

contribute to the update, control and monitoring of syllabi is missing and is vital to the educational process improvement.

5.3 Planning

Semester planning is mostly done through the academic members either individually when it concerns lecturing or in group meetings when involvement of more parties are required. In some faculties every lecturer is supposed to submit an activity plan for the whole year whereas in some it is required on a semester basis. Some of the participants have stated that the quality assurance committee have drafted action and activity plans that faculty members need to fill out. Participants provided a variety range of ways they would plan the semester. Some of the answers were not clear as it hinted to the hiring academic members process as having no plan, though hiring was used as an example in the text of the question. The participants also have mentioned that a quality assurance committee has provided forms that help with drafting action and academic plans for the semester. Another participant noted down in their answer that they would hold a general meeting at the department level, divide the tasks to the lecturers and devise a plan accordingly. The same participant even mentioned the execution of the plan being controlled through out the semester as well. Another participant mentioned having a five year strategic plan where they align their annual plans to the strategic plan.

As a common point among all the various answers one could see that the participants mostly devise a plan at the beginning of a semester or the beginning of an academic year, for both semesters. Some seem to depend on their common sense and past experience on devising such a plan.

As for tools that would be used to devise such a plan existence of paper based templates, usage of syllabi and course content, online software tools without naming any specific tool, Excel sheets and soft copies of forms prepared by the Quality Assurance Committee of the university and Moodle were mentioned.

Every participant agreed that planning a semester was indeed a very necessary activity for the semester, but many didn't know or thought there were no guidelines and regulations for planning. This presumption is partly true in the sense that it does ex-

ist but many of the staff members have no or limited access to those guidelines. This is just another reason that highlights the importance of documentation and easy access to those documentations. Although all participants of the survey find it important and necessary to plan semesters and the majority agree on having a fixed mechanism, when it comes to commitment, many have doubts. A goal, a plan without commitment to follow and apply is as good as not having one. Even one of the participants stated commitment to the organizational goals as major requirement. The following diagram 5.5 presents here the two contradicting statements.

Agreement on Fixed Planning vs doubts on existence of commitment

Figure 5.5: The contradiction between agreement and commitment

Participants suggestions on bringing and encouraging everyone to be committed to the plans made and give their best while executing the plan was mainly suggesting provision of a monitoring mechanism, through checklists, holding regular meetings with involved parties, a special task-force or committee to do the monitoring through evaluation of forms and consensus. The findings suggest planning without commitment would have a negative impact on the students desired level during the current and follow up semesters.

5.4 Quality Assurance

Quality assurance is a new initiative that has been deployed by the MoHE to make universities evaluate the situation and improve the quality of services. Currently, self-assessment and peer-inspections are applied. The final goal is to achieve an international accreditation from international accreditation centers in the region. The nature of the process is very unclear and maybe only those involved in the decision making level of the project know about the standards that are used to measure the quality.

To the participants of the survey this initiative seems to be very vague and unclear as they stated and defined the initiative in their answers. Some have considered it as a committee with personal oriented actions, however all name it as a paper-based, paper-work process that check quality in terms of quantity methods using questionnaires and self assessment forms. It is also mentioned in some of the answers in the questionnaires that quality assurance is a key to the successful implementation of faculty plans. Every participant had defined the process the way they had experienced and understood it. Some believe this quality assurance will not bring much improvement the way it's implemented. However, the initiative is a pilot project in its very early stages. The optimistic views in the questionnaires suggest it could provide a means to get improved teaching material, giving professors a sense of being checked regularly through students evaluation and feedback that could then yield to further improvement.

Could QA Findings be used for self-improvement?

Figure 5.6: Quality assurance and self improvement of lecturers

The majority of the participants reported a regular quality assurance check run ev-

ery semester; however, to the findings of the quality assurance impacting on self improvement of colleagues only 50% gave a certain answer. The other 50 % were either not sure or totally certain that no one would improve or change themselves due to the Quality Assurance findings. That brings us again to the importance of commitment to the process improvement.

5.5 Further Training

Taking the young age of computer science establishment in all over Afghanistan into consideration, a huge amount of work needs to be done. The people involved require much job training and that has been also highlighted by the participants under several sections of the survey. Most of them wish to have received a training on knowing the procedures, applying and understanding them accordingly. For most of them it has been difficult to start their new carrier as a faculty member without proper training, understanding the processes at the faculty and their relevant guidelines. Short term trainings as well as long term trainings for staff members were pointed out to be very trivial at all stages in order to present good results.
The list of topics that has been suggested by the participants are interesting to look at. Trainings on basic laws of MoHE; laws of recruitment; students and employees attendance; management; exams; business administration; information about different committees and their responsibilities; full description on ways to manage lecturers; teaching methods; collaboration with lecturers; OCL (Object Constraint Language); curriculum development; workshops on office administration, reports and letters writing; conducting research; use of technology; soft and communication skills; research analysis; credit point system and its regulations; leadership; hardware training and organizational behavior are some of the unique on job trainings that participants wished to get at the beginning. Many of these trainings such as administrative management, laws and regulations and teaching methods are also mentioned or wished by several participants.
Topics such as inter-university students exchange programs around the country, building close ties to the industry and companies to find students internship places, having a stable electricity above all were a few issues that participants pointed out as

being important and crucial for motivating the faculty. Some even tagged them as a requirement.

5.6 More Processes

This category of the questions investigated in two main directions. To gain input of participants on as many processes that could be counted out and to see their level of satisfaction in regards to knowing processes on its own and expressing their understanding about the quality of how those processes are handled. The resulting outcome of these questions led to indentification of other processes and process areas that were not thought about at the earlier stage of this research.
Two consequent questions of the Survey (Appendix D Q35 and Q36) dealt with finding the current level of satisfaction of participants on the ways processes are being executed and if they would want to change them. The first of the two questions is depicted in the following diagram (Figure 5.7). A higher percentage (77,27 %) of participants are not happy with how the processes are handled in their institutions. Some 9,05 % of them decided not to express any opinion and 13,63 % were happy with the way the processes are handled in their faculty. However, in the next question where the participants were asked if they would want to change the current processes or processes areas 95,45 % of the participants answered positive. Here the expectation was to get the same 22,72 % of the participants answers would be no or that they wouldn't know. This difference of answers is a good indication that despite all, most of the time, they are willing to bring changes, and improve the processes in a better way. The will to make changes and improve the existing processes is present.

The participants named many processes and process areas that they found important to the functionality of their institution or that they would find it important to understand and improve. Processes highlighted by participants were official correspondence process, financial, budget issues and procurement as complicated; long and time consuming. Semester evaluations, exams guidelines, thesis evaluation, activity evaluation, check and update syllabi, lectures capability improvement were more or less processes that were mentioned by several participants in different

Participants satisfaction Level

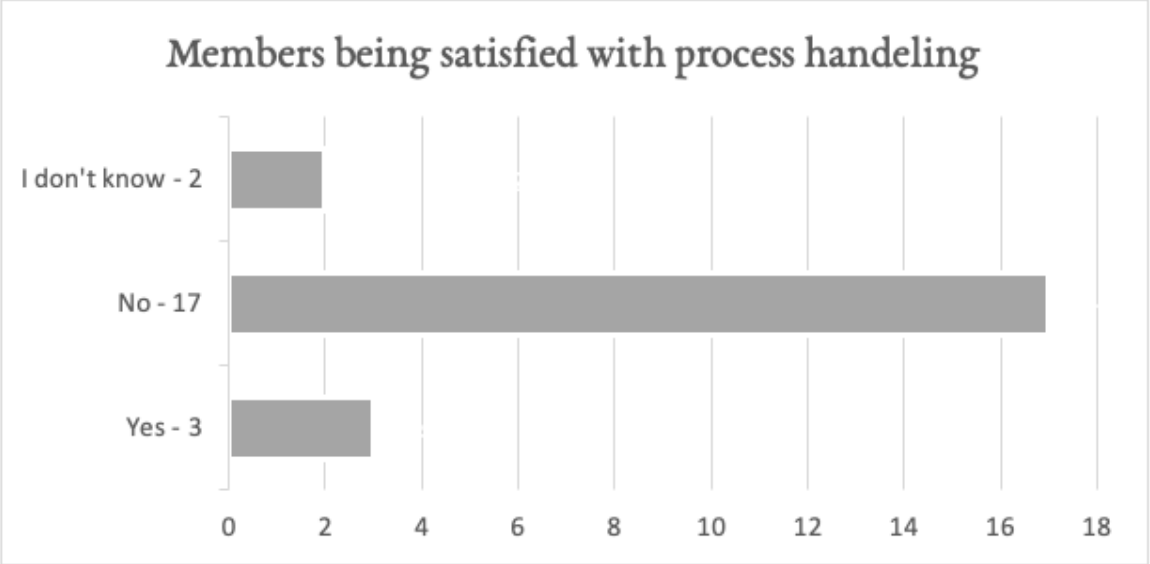

Figure 5.7: Participants level of satisfaction with the way processes are handled currently

words, but mainly were pointing to the same direction. Financial and administration autonomy, to give faculty members the freedom to plan and execute their plans. Doing quality assurance assessment systematically, students and lectures management system and its monitoring and evaluation, checking quality, developing curriculum, modernization of the administrative systems were also seen among the processes that the participants suggested. A few left their answers blank, it could have been that they have over seen it, wanted to write it later and forgot about it or just chose not to share their ideas.

Having access to laws, regulations and guidelines of MoHE and University administration and whether they were easily accessible once again drew different opinions. Judging by the participants administrative role next to their main academic role, one can differentiate clearly. Those who have administrative roles in the faculty i.e. deans, deputy deans and department officers, the nature of their role requires them to acquire those documents and their connection to the administration board of the university gives them easy access to those documents, where as the others who have an academic role only and work as lecturer or academic member they have either stated that they didn't know the answer or have given a clear answer that they didn't have such a possibility to gain access to those documentations. The following two diagrams are exhibiting these controversial statements.

Figure 5.8: Participants access to laws, regulations and guidelines of the institution

Around 81,81 % of the participants believed in the possibility of the current processes having the potential to change, the rest either didn't believe it would be possible to bring changes or avoided to share a direct opinion. In a knowledge thirsty academic society where most of the members are also young, it is a good sign that the young generation want to bring changes to the old methods and the way processes are handled. The need to learn more about the processes, the way they are handled is indicated by around 77,27 % of the participants where the rest either didn't know and were sure they didn't need to learn more. For the later case, it is not clear if the statement comes out of the lack of their interest, or that they are so experienced that they don't feel the need to learn more.

A bunch of processes were suggested by the participants of the survey which they thought would need improvement and to be further worked on. Semester planning, faculty administration, quality assurance, hiring lecturers and staff members, checking thesis, exam results processing, checking, updating and monitoring syllabi, improvement of knowledge and capability of lecturers, teaching, event management and holding conferences, students projects, students exchange program, collaboration and coordination with local and international experts, advanced students and lecture management systems, internship programme for students, regulations and laws of acquiring universities autonomy, lecturers assessment, requirements manage-

ment, issuing student's graduation documents, quality assurance, capacity building, modernization of administration processes and all processes were some of the common answers that were provided. By examining the answers closer one comes to the conclusion that the need to improve; the thrive to change and will to get involved in changing processes exist and one need to figure a standard; a scientific way and or a framework that could get these scattered points together and help the ones who want to get involved in process improvement.

5.7 Summary

Chapter 5 tackled the approach of the study at hand presented an analysis of the data obtained through the online survey forms. This analysis helped the author point out process areas that need the most attention and majority of the participants have expressed their concerns towards those processes. This work enjoys the qualitative data collection approach using questionnaires. The structure of the questionnaire is explained and the open-answer questions are evaluated and analyzed. The over all conditions of the IT development pace in the case study under consideration of this work is explained and the grounds for the research questions and theme of the work was paved into. This chapter prepares readers for the followup identification and analysis of process areas that need attention and can be worked out.
These results lead to a proposal for a competence oriented IT Education. They all agree that much needs to be done and one could still improve numerous processes. The evaluation of this survey leads to the definition of a number of important processes and process areas that are suggested and discussed in Chapter 6.

6

Assessing a Competence Oriented IT Education

Chapter 6 takes the process areas from the CMMI that could deal with the process areas found in lights of the analysis of the questionnaire in Chapter 5 under the loop. In order to introduce the process improvement initiative, building good grounds to justify the act, earn trust of all the stakeholders and show them an enhanced process is required. The goal of this study is to show the existence of standard means that are widely practiced around the world and to assure the stakeholders that those standards can be customized to the needs and the actual situation in the field.
An interpretation of a mini CMMI model that reflect those nine selected process areas can be found in Chapter 7. * The CMMI terminology is simplified and adopted to the working environment of computer science faculties.

Section 6.1 discusses two related process areas together — the Requirement Development and Management process areas. Every institution has its own requirements and involves development of those requirements in certain ways. The requirement

*The structure that is a reflection taken from the original CMMI Model for Development is presented and compiled in Chapter 7 to give the readers a means, a starting point when it comes to actually applying the model.

development and requirement management items that one need to focus on a faculty of computer science has been explained in this section.
Section 6.2 focuses on the importance of having a syllabus development system and mechanism that would allow access to update teaching plans and teaching material of each subject. Such a system provides transparency to what the student should expect and allow monitoring and controls action on teaching material easier.
Section 6.3 explains the need for planning semesters and the importance to monitor and control the planned activities. Monitoring and controlling the activities taking place during a semester is as important as planning them. This allows us to know where we are standing at a specific point in time.
As a recent step towards improvement of quality in all over government based universities, a quality assurance initiative has been introduced by the MoHE. Section 6.5 provides insights to the matter and supports the cause and introduces other aspects that could be considered next to the plans currently being executed for this purpose
As processes are the core to existence of each organization, section 6.4 provides explanations to the importance of process definition and process improvement and how they can be achieved. In this section, which is a combination of two process areas, the readers read more about various processes that need special attention in the Faculty of Computer Science at Herat University.
The last Section 6.6 introduces the means for planning organizational training and how the organization should focus on building training capabilities in the long run. In this section you will read what the Faculty of Computer Science is doing regarding its organizational training policies.

6.1 Requirement Development and Management

The Faculty of Computer Science at Herat University, like many other computer science faculties around the country, is still a young and newly established entity. The main objective of the faculty is to train the young generation of the country and provide them with the recent knowledge so they can get involved in the IT related jobs within the country. As a national and government based institution, the students who are being enrolled in this institution come from all over Afghanistan. For

the year 2017, some 177* students have been introduced through the Kankur Exam's procedure and this group of students are supposed to begin their first semester in September 2017.

At the moment only a Bachelor study program is being offered at this educational institution. However, according to the strategic plans of the faculty, which is in accordance to the strategic plans of the University as well, integration and inauguration of a Master study program within the faculty is foreseen for the year 2025.
As a developing entity that has been actively working more than 10 years offering study programs in computer sciences and informatics, it is dealing with two types of requirements: The operational requirements, in order to be able to run the facility and offer its educational services to students as well as the strategic development plans requirements. These two types of requirements are introduced in the following section 6.1.1 whereas in section 6.1.2 details of standard tools and the potential contribution of CMMI to development and management procedure are explained.

6.1.1 Onsite Requirements

In order to understand the requirements, it is important to understand what type of assets and entities we are dealing with at Computer Science Faculty. The following points are the main requirements and their associated issues.

Staff Members

In chapter 4 section 4.3.1 a detailed explanation of the organizational structure of the faculty is given. In the given diagram a clear image of how the faculty's staff members are organized and how the hierarchy runs through the faculty is presented. Staff members act on its own as a requirement for the faculty and then again they have their own requirement as they need to run processes and thus have access to resources. The staff members are divided into academic members and operational/administration members. The main task of academic members is to provide learning opportunities to the students, teach the classes, manage the Syllabi, plan their lectures, offer courses, carry out the exams and conduct research. From the organizational perspective they belong to one of the departments and they can as well take up an adminis-

*List of Candidates for Enrollment Provided by the Dean of Computer Science Faculty on 14.Aug.17 at 13:13 per Email

trative role next to their academic role (MoHE 2015a).

According to the regulations set by the MoHE, each department should have a minimum of three members and maximum of seven members (MoHE 2015a). It is the first requirement to have at least three members for establishing a new Department. The establishment of a new department within a faculty would be to offer a new study program or a new study field within the context of the faculty. The maximum is limited by the total number of credit hours of teaching offered by the department per semester.

In early 2021, there were four Departments in the faculty of computer science with a total of 22 academic members. Completing the current number of academic staff members is one major requirement for meeting the workload balance. The hiring process goes after the establishment of an academic vacancy at the target department. This vacancy is announced publicly through various media sources for a total of three months. Candidates willing to join and meeting the basic qualifications apply and their application files are investigated for verification and validation purposes. Priority is given to candidates with Master and PhD degrees. Those with a Bachelor degree whose total GPA is over or equal to 75% and who have no or at most one failed attempt in a subject's exam through out their Bachelor studies are shortlisted for a written exam that consists of ten explanatory questions. A candidate who obtains an average mark of at least 60 is considered passed. Then the top two candidates of the written exam are given specific topics by the department to prepare for a presentation within a time frame of two weeks. A joint commission composed of lecturers and department officers administer the whole process*. The candidate who has earned the highest marks in the oral exam is selected to be the new junior assistant professor and appointed in the available vacancy.

The administrative staff as depicted in the organizational chart in chapter 4 figure 4.3 is responsible to carry out the operational tasks related to the overall activities of the faculty. Those activities vary such as enrollment of students, record keeping and data entry, room service or transportation. The organizational structure is based on the futuristic view that the faculty will be expanded and would need those staff

*Sometimes, to make this process more transparent, all faculties are given a single date where applicants attend the written exam in one day.

members to run the tasks.

However, as of early 2021 there were five operational staff members hired and working. Despite the need for more operational staff the university fails to provide the right financial and structural resources to hire new people so that most of the workload is left on the current people in those positions. Having enough staff members is considered a requirement for the execution of the semester plans and the general overall strategic plans of the faculty.

Another service that is offered by the Faculty of Computer Science is a network administration team that consists of volunteer students and one academic member who works extra hours to maintain the network, do the troubleshooting of all PCs in the PC-Pools and often helps and supports students with their hardware and software related issues. Even though the formation of such a group is foreseen in the organizational structure of the faculty, as of early 2021 no one has been appointed to this post officially.

The library needs to gain access to other online libraries. Since access to a reliable and fast internet connection is a challenge, a caching mechanism should be considered. The books often accessed by students should be locally cached at a server in the faculty or the library itself. Gaining access to internationally available resources requires planning, budgeting and is important for education.

Physical Space

Offices, classrooms, lecture halls, seminar rooms, PC-pools, network and troubleshooting teams' rooms are all part of the physical space needed for a faculty none of which the Faculty of Computer Science owns. Lack of a physical space has been a challenge to the faculty and the University of Herat since the establishment of this institution. The available physical space within the university is shared among all the faculties. However, there is an ownership behavior that still runs. In the main developing and construction plan of the university, there is a piece of land allocated to each faculty. In 2020 the construction project of Computer Science Faculty's building started and hasn't been finished yet (June 2022).

Now the administrative offices, PC-pools and library of Computer Science Faculty is located in Civil Engineering Faculty's building whereas the classrooms are located

in the Fine Arts Faculty's building*. Due to the high number of students and several classes offered for each group, the class schedules are running from 08:00 until 16:00 pm. As sometimes a student gets to have a lecture at 8 in the morning and the next at 13:00 in the afternoon. The faculty and the academic members are left with big trouble, with nothing to do in between and no proper self-study environment available at the university. The person in charge of generating a schedule tries his/her best to leave the smallest gap possible between two subjects.

The network administration team, which offers support and troubleshooting services to the faculty's network infrastructure and students personal computers, has been allocated a room. This room works as a PC Workshop for all the computer, hardware and software related problems of the faculty. This team also requires hardware and software to run the faculty's IT infrastructure smoothly and their needs should be considered, managed and planned accordingly.

Teaching Material

PC-pools, computer labs, networking labs, books and multimedia resources, class stationary such as boards and markers, paper for exams and other supporting material are some of the resources that are required for conducting a teaching session. The teaching material is often specified in a syllabi planning process, but to have them ready for the teacher to use, requires proper management. Should they not be available, they need to be provided and means to acquire them is needed to be developed.

There are 32 PCs set up in three rooms as PC-pools. This number of PCs needs to help more than 500 students to run their exercises, research and help them study. Not every student can afford a computer and Internet access at home. At the same time, these PCs and the PC-pools are used by certain subjects such as network security or fundamentals of programming tutorials where students run their practical experimental approaches for helping other students understand the learning material. Acquiring more PCs and managing the usage time of the PC-Pools among all the students requires a systematic approach.

Teaching as a Service

*In a normal situation where a central room allocation body would exist it wouldn't be a problem. The ownership issue is a very hot topic and every faculty wants to have its own environment; sharing resources are not very welcome.

Service lectures are certain subjects that are considered as secondary group of subjects in a field of study. For example, English and Management are two soft skill improvement subjects that all students who study computer science and Informatics at Herat University have to attend and successfully finish. Since these two subjects are not main subjects, they are needed to be taught by lecturers with economy and management qualifications. In this case a lecturer from the Faculty of Economy for management subject as well as Literature and Linguistics Faculty for English subject would be asked to teach these subjects.

The same rule applies for Mathematics in Computer Science, where lecturers from both Natural Sciences and Engineering faculties can take over the teaching task. At the same time, most of the faculties at Herat University have Computer skills training as their secondary and soft skill subject offered to first year students mostly, where someone from the Faculty of Computer Science has to offer the teaching. In average there is a total of 70 credit hours Computer teaching classes per semester. This amount of credit hours requires at least three full time lecturers who only teach those soft skill computer programs in other faculties of Herat University. Hence this large number of credit hours difference paved the way and justified the establishment of a fourth department.

Working Groups

There is a total of eight working groups which are called committees as described in chapter 4, figure 4.3. These working groups are made up by the department members, sometimes from the same department, but mostly from all the four departments at Computer Science Faculty. The goal of these working committees is to work on issues that legally require attention and participation of more than one person or department to deal with. The number of members in each group has to be odd, in case certain issues would need voting for and it is easier to get a final and clear decision with odd number of participants when an issue needs to be decided with voting.

The workload among these working groups are not equal, for example the Disciplinary Committee can be formed once per year to investigate and discuss a disciplinary issue that has been raised in that particular semester. This group does not have many requirements and needs. On the other hand, the Exam's Committee work-

ing group requires much planning time, scheduling, controlling and monitoring the examination processes. They require access to physical resources and stationary to arrange the written examination sessions. They also need to carry out and plan re-assessment sessions for complaining students who are not happy with the obtained marks.

The Quality Assurance Committee should have access to all the Department officers plans plus work progress and should often conduct surveys among teachers and students to gain feedback on progress and satisfaction of the students. Each committee might not have the same amount of workload, but they have their own requirements and need access to certain resources. These are requirements that need to be managed and developed in time.

Further Degree Programs

According to the strategic plan of Computer Science Faculty, the establishment of a Master study program is foreseen by 2025. The establishment of a Master degree program has a number of pre-requisites and requirements that need to be fulfilled before starting the procedure.

According to the constitution of Afghanistan as well as the Higher Education laws a bachelor degree education has to be offered for free to everyone in the state-run universities and higher education institutions who pass the general entrance exams' requirements (Constitution 2004; MoHE 2015a). If a university manages to offer Master degree programs, students who are willing to pursue the program will need to pay a certain semester fee. The fee is collected in a government account and the collected fee is administered through the Finance Ministry. The institution earning this money cannot have direct access to the money; should they need to use the semester fees for acquiring certain products or services, they should file an application that passes through a long financial process.

There are certain ground rules concerning the establishment of a Master study program. The Faculty that plans to offer such a program should have enough physical space, well equipped library, labs and the teaching material as well as qualified staff members (MoHE 2015a). There should be a minimum of four qualified academic members to establish a master study program in only one field of study. These academic members require a PhD Degree. However, a combination of three PhD mem-

bers and one member with a terminal rank of Pohandoy* can also qualify the faculty's department to start a Master degree program(MoHE 2015a).

These four members should plan everything from the very beginning and develop all the requirements, such as curriculum, syllabus, study objectives and means of supporting the students with the physical space. They would then need to put up a complete proposal, which declares all the plans, facilities and requirements including criteria for students enrollment into the new program, to the MoHE. Once the ministry approves, the faculty can start the realization of the Master study program.

6.1.2 Arguments and Explanations

The requirement management process area deals with managing the requirements needed for the execution of semester plans and other operational plans of the faculty. Section 6.1.1 categorizes the requirements of the faculty. Each of the categories have several requirements and need resources. In order to use the available resources fairly, a proper management mechanism has to be in effect. The requirement management process area introduces specific practices and relevant sub-practices that can help with the achievement of the requirement management improvement.
The requirements are managed on a person-centric and daily basis and often lead to slow, missing and conflicting results. The absence of such mechanism makes it unclear to the organizational stakeholders how to manage those requirements. Even though there is no fixed and well-documented approach to managing those requirements they are still used, and the operations are running. That is why the current state is given a Capability level 1 status (Capability Level 1: Performed) according to the CMMI model. As this Level indicates that a process that has reached the Capability level 1 accomplishes that the needed work(Chrissis et al. 2011). In order to mange these approaches and develop a systematic manner to manage and develop requirements; a requirement management system has to be put into focus that will then in turn lead this process area to capability level 2. Systematic approaches need to be concentrated to manage requirements. Then a better development mechanism for requirements can be reached and once grouped with other Process areas a higher maturity level can be yielded.

*Refer to chapter 2, section 2.4 for more details on the academic ranking system.

The Faculty of Computer Science's strategic plan indicates the establishment, development and deployment of a Master degree program for the year 2025. There is no action taken towards collecting, development and gathering the requirements yet. The only step towards realization of this goal so far was sending two lecturers in 2015 and one lecturer in 2017 to attend PhD program in Germany. Another faculty member started attending a PhD program in 2018 in Iran. The first two should be able to finish with their plans in early 2018 and the last one in 2020. Therefore realization of this goal seems impossible and unrealistic for this time frame since only one of the four candidates managed to finish his PhD in 2018.

The Requirement Development process area, its specific goals and practices along side with their relevant sub-practices are a good ground for the development of the Master degree program from the scratch. This process area lays the foundation for establishing a systematic approach to the establishment, elicitation and development of a Master study program in computer science. If taking this process area would be considered as a tool in the development process of the Master study program, a lot of troubles would have been saved. This process area helps finding the constraints, limitations, costs and cost drivers, the time constraints, risks and needs (CMMI 2010b) of such a program. The question of whether the deployment of such a program is ready will be answered at the very beginning of applying this process area.
If this IT educational institution wants to establish this study program as part of its long term evolution and progressing plans, it is highly recommended to use and apply the requirement development process area. The needs and requirement elicitation answer the question to all the entities this study program requires. A thorough investigation that would consider the job market requirement, government strategic plans concerning the IT systems in the country and organizational policies at the university level should be studied. The related stakeholders at those three points have to be interviewed, questionnaires need to be distributed among former and current bachelor students. The needs elicitation will help in developing a study program that suits those social needs. The master program will need to balance the academic and industry demanded competence of students.
Another major helping point of this process area is the identification of interfaces between various entities that are required and play a role in the development pro-

cess. This aspect helps understand the requirements, for instance those categories that are already explained in section 6.1.1. The identification of interfaces supports comprehension of the inter reliability of one entity to the other. For example, if the construction of a building to meet the physical space requirement criteria was considered, the appropriate budget for it would need to be found and allocated. The financial sources that provide such a budget are the Finance Department at the Ministry of Finance and Planning Department at the MoHE. The Planning Department approves the need for the construction of the building and the Finance Department allocates the budget. Other interfaces for the realization and development of this requirement are the Administrative and Financial Department of the university which functions as the verifying, validating and the relaying body at the university. Any project and request that needs financial funding has to go through this body. Knowing those interfaces would help the planning and development of the proposal.

The final Specific Goal of the Requirement Development process area focuses on analyzing and validating the requirements. Any proposal, plan, and operational concepts that is already developed and ready to be dispatched for deployment needs to be validated and thought through properly. The establishment of such a mechanism that validates execution plans and that contributes to the achievement and acquiring of the requirements is the optimal goal of the Requirements Development process area. That is how an organization can reach a level 3 maturity level, once it has established a mechanism that elicits the requirements, develops them and re-validate them right before the execution of the development plan.

6.2 Syllabi Management

A Syllabus is a detailed lecture plan often prepared by the lecturers to plan their sessions for conducting the lecture. This document indicates the nature of the subject, all the contents that are supposed to be provided to the students, the resources and requirements that are needed to follow up the lecture, i.e. multimedia, slides, lab requirements and room. Furthermore it indicates the dates for exams or any other specific activities that are supposed to run through out the semester. Each session's duration, the contents to be offered and the extra curricular activities related to that

subject are to be highlighted and indicated in this document.

It is one of the department's tasks to collect and keep a copy of the syllabus at the beginning of each semester. The syllabi can also be a basis to monitor and control the semester progress. Updating, maintaining and creation of a syllabus is a continual task that has to be executed every semester. Thus, such a process area needs to be watched closely and hence the syllabi management process area comes into effect.

6.2.1 Current Situation

The following sections provide the readers with the information and depicts the situation of how the syllabus development process is managed in the real and provides the relevant CMMI applicable process area as a means for development consideration.

The study program of Computer Science Faculty on the Bachelor level is a four years program focusing on building, technical, theoretical and practical competence of students who attend this educational program. The four years are divided further into two phases. Phase one includes 4 semesters of studying general, basics and fundamental issues of computer science. The second phase concentrates on providing focused studies in three major studies*, Software Engineering, Communications and Operating Systems as well as the Information Management Systems. In the second phase, the students also have to take soft-skill courses such as IT Management and Scientific Writing. These courses are common for students of all the three majors.

The Bachelor study program is designed and arranged in a booklet that introduces the Faculty of Computer Science along with its international affiliate i.e. the Technical University of Berlin†. Furthermore, information on the goals and skills development focus of each study major or department is presented. The amount of credit hours required for each subject per semester is also specified.

There are several ways and approaches to calculate credit point (hours). Relevant importance, absolute workload and contact time are some of the common approaches to evaluation of credit point system around the world (Boele 2009). In Afghanistan the credit point system is approached after the contact time. The contact time con-

*Administratively each study major is represented by a department

†The cooperation also ended with post Aug-2021's political changes in Afghanistan

siders a student's direct contact and presence in the class as a credit hour. According to the regulations set by the Afghan MoHE (MoHE 2015a) a subject cannot have more than five credit hours. That is the maximum a subject can be offered per week. An academic hour is 50 minutes long.

A semester is 16 weeks long; so if the maximum number of credits for one single subject is five, it would give us a maximum of 80 academic hours to plan the contents and exercises of the subject that are needed through out the semester. Appendix C exhibits a sample syllabus for the Operating Systems subject, which is part of the Technical Foundations of Computer Science module. The subject has four credit hours worth and has 64 hours of total contact time for students, including the midterm and final exams.

The Bachelor study program catalogue describes the modules and their relevant subjects. The catalogue specifies what competences are expected from the students and what type of activities have to be considered in running the course. Further details of how the course is managed and deployed are explained within the syllabus. General course rules and policies are as well as contents of each session is described within the syllabus.

6.2.2 Argument and Explanation

Syllabus development is an essential task of each department member offering a course in a specific subject. Such a continual task requires being both up-to date and also in harmony with the goals of the study program. The contents developed and enlisted in the syllabus of a subject should consider the pre-requisites of the subject and lay the grounds for the follow up subject. Syllabus is considered as a medium that serves the institution for quality control and management on one hand and provides students clear guidelines and a futuristic view on their competence and skills development on the other hand. The syllabus development process should be institutionalized and a systematic approach should be given to it. This Process Area finds itself at capability level 1 currently.

The syllabi management process area explained and formulated in section 7.2 of chapter 7 provides a clear structure to the creation of a system that would handle syllabi management and syllabi related activities. The specific goals of this process area

focuses on the creation of a syllabus Management System. The existence of such a system helps with the development of content for the process. The specific practices of the first specific goal outlines the importance of knowing and identifying all the items required for such a system. If one wants to apply this specific practice on a single subject, it would mean all the medium and teaching material required to carrying out this specific lecture has to be identified.

As survey participants also emphasized on the necessity to have a syllabus management system. Such a system provides an easy access to students who take the course so that they know what they are expected to learn. Then again, it also allows the management to control the teaching process of the subject. When a syllabus is developed and managed by such a system that grants reading access to students, the teachers can adhere to the teaching plan and contents of the syllabus. They cannot change the contents of the plans the way it pleases them.

Furthermore, the process area's second specific goal emphasizes on the development of a control mechanism to track changes. Changes are necessary and contents of the syllabus have to be updated regularly. It is also part of the tasks of a department that needs to apply and follow up regularly. In addition, the existence of such a change control mechanism allows to see the new updates and improvements to the teaching quality and contents every semester.

Organizational training can be part of the strategic planning of the Computer Science Faculty. As mostly the higher level trainings are outsourced outside the country, it is often common for the lecturers to go abroad for long qualification training periods. At the moment there is a record of syllabi developed for all the subjects in 2013. Appendix C shows a sample work from 2013. Since then different teachers have been sent outside the country for further qualification trainings. Lack of a tracking and controlling mechanism has led to the variation of teaching habits and contents. Not everyone has pursued the same syllabus that was developed in 2013. That is leading to missing competences that the students need in the follow -up semesters. In some cases, the department had to introduce a new subject to compensate for the missing competence gap as well as the lost credit hours.

If there was a central mechanism that control and monitor the teaching process and update as well as developed process of syllabi, an overlap on contents would not

happen and the changes would serve a better and updated content, hence not reducing the quality of the teaching material that was supposed to be offered in the course.

The Syllabi Management process area focuses on the main and important practices that include development, update and maintaining the syllabi content. The sharing mechanism of such a central management system secures the integrity of the entire system. Departments can easily manage the development process of the syllabi content. They can be always kept updated and any changes to the contents of a single subject are notified. Approval takes place upon needs; the integrity of the changes and its effect on other subjects are checked regularly.

6.3 Semester Planning, Monitoring & Control

Activities involved in running the semester are teaching, students admission and transfer, resource allocation, offering Service lectures to other faculties, syllabus development, and arranging the time table with all the involved parties.

Concerning this matter, challenges can be faced which need contingency plans to overcome and/or avoid those challenges. The first section identifies the key items that are important to be considered for planning. The next section focuses on introducing tools and standards that could help with the realization of those steps while compiling the semester plan.

The Semester Monitoring and Control process area focuses on the observation of progress during the semester execution. The results help with future semesters planning, organizational training and process focus and to weigh the success or failure of the semester plans. Using the Semester Planning process area operations and tasks through out the semester can be planned. Likewise, the developed plans can be monitored and controlled through this process area. It is a useful mechanism to observe the semester's progress and find out the weaknesses and strengths of the previous plans so that future planning can be enhanced.

Planning has a futuristic image of what will happen and how certain events should take place in the coming future, whereas monitoring and control work on finding the past actions and present work progress. Its focus is to find out the image that was

foreseen earlier and to determine whether it reveals itself accordingly.

6.3.1 Planning Items

Throughout the semester there are two types of activities that need to be addressed and planned, that is, the operational activities and the academic activities. The academic activities are those concerning preparation of teaching material, training staff members, exams, offering lectures and providing consultation hours to both teachers and students. The operational activities are those surrounding academic activities. Students admission, their dormitory management, resource allocation to different activities during the semester, building the schedules, training the staff members who contribute to the execution of academic activities.

Schedule

The classrooms' time of use is shared among all subjects, thus a schedule to determine and define which lecture is offered in a certain room at which time requires consideration of several external variables. Often a lecturer has to teach two to three subjects for one or more classes in a day. Creation of the schedule is accompanied by challenges such as the same teacher for multiple subjects or classes, limited available physical space and teacher's personal preferences in regard to time. Those teachers who offer service lectures require extra attention, as the service lectures should be set in accordance to the time table of the teacher at his/her original faculty.

Challenges

The identification of challenges is another factor that can help with the compilation of a conclusive and precise semester plan. As knowing the problem is considered half of the solution, so is the understanding and identification of challenges through out the semester useful. It helps with finding solutions and possible preparations for challenges to happen. Physical space is a huge challenge and will remain a challenge until the construction of another building for the faculty at Herat University's campus is realized. Students conflicts, requests for exam papers revision and asking for extra marks to pass a subject, requests for change of lecturer, students attendance records are among the dynamic challenges that emerge almost every semester. Public holidays as well as natural or man-made disasters, need to be addressed while planning. In the war-like situation of Afghanistan the flow of the semester is affected,

loosing lecture time is inevitable, for instance, the semester is cut short for political reasons or for early arrival of the winter's cold days. Thus, a contingency plan is always required in this kind of situation.

Data

The following list indicates a number of data items and types that are generated and have to be kept throughout the semester.

- Students Admission records: These records indicate the results of the students' participation in the Kankur Exam and their admission to take part in the Faculty of Computer Science in one of the current three departments.*
- Students Credit sheets: The credit sheets are mandatory lists filled out, signed by the students and approved by semester supervisor, department officers, Students Affairs Manager and the Dean of the Faculty. This list indicates the number of credit hours and subjects selected by a student.
- Exam papers: Due to the high number of students at each semester, exams are always managed in the written form. Exam papers of all subjects have to be kept for revision, should a student protest their marks, and for future possible complains. Legally, the exam papers must be kept for a period of one year, the longer storage is not a problem.
- Exam marks: Students result marks are stored in each students' credit sheet in their personal file. A copy of each subject's marks are signed by the lecturer, Department Officer and the Dean of the faculty and then sealed with a stamp. Later on, a whole book of exam marks for one graduating batch† is created in three copies. They are signed and sealed by the faculty, and the university's vice chancellor in Students affairs and the Chancellor. One copy stays in the Faculty, one at the University and the third is sent to the Ministry of Higher Education.

*Since Fall Semester 2017, school students who take part in the Kankur Exam get a chance to select their desired major of study, i.e. the department at which they want to pursue their Bachelor studies in Computer Science Faculty.

†A Graduating Batch is a group of students who have completed the fours years of Bachelor degree program.

- Students attendance records: According to the MoHE laws, a student is legible to attend exams in a certain subject, when they have managed to participate in more than 75 per cent of the semester period. Any student failing to complete this attendance requirement is to be disqualified for taking the exam and should repeat the subject. Failure in more than half of the credit points a semester, yields to repeating the whole semester.
- Staff members attendance records: These records generate a report of all lecturers and administrative employees attendance at work. This attendance report is used as a basis for the salary calculations and payment.
- Meeting minutes: The faculty board of meeting, the working committees' meetings as well as the department meetings are documented in log books. Topics of discussions and related solutions are recorded for future reference and signed by the participants of the meeting.
- Documents and Letters: The official correspondence between the faculty and university as well as between departments and the faculty are kept and archived for future references. The correspondence can be informative letters indicating decisions made at various meetings in the upper management or inquiry letters requiring the faculty or addressed entity to take some action concerning the contents. These types of documents have a long life preservation policy.

Basically every transaction that takes place within the organization generates data. It is required to know your data generation sources and to plan a proper mechanism for safe guarding those data. The access control should be definitely applied. If something needs to be changed, a mechanism to approve those data changes needs to be in place; thus, all these actions require planning as well.

Resources

Looking at the organization from a management perspective, everything that contributes to the execution of a semester is considered a resource. Resources can be human as in staff members and lecturers. They could be subject specific as per requirements for teaching set at the syllabus including teaching material and physical space. They could be the computers and PC-labs that are to offer learning environment to the students. They could be the library and its attached requirements and resources.

Another key resource that one needs to provide students is the peace of mind and feel of security and safety when students arrive at the faculty. With all the stress and pressure they have in the outside world, once they arrive at the faculty it should feel like a second home for them. Although this peaceful environment is a logical entity and can't be defined in terms of physical environment, students, specially the female students, need that reassurance to be able to feel secure. Hence, it can lead to better performance of students.

Knowledge and Skills

Staff members require further training in various fields. The lecturers need to understand that teaching is not the only job they have. They all have administrative responsibilities too. Therefore, on the job management and administrative trainings where it allows them to learn all these management basics in real working environment is essential.

Furthermore they need to take extra degree qualification programs. Those with a Bachelor degree need to obtain Master degree qualifications and those with a Master degree need to pursue a PhD program. This is part of the long term planning activities of the Faculty. They all need didactic trainings as didactic and pedagogical courses are not offered during all degree programs.

The administrative employees are often hired with different skill sets. They require training in office equipment and also need intense training in management and administration. That is why their skills and knowledge enhancement are as essential as every other academic member of the faculty. They also need to under go certain training programs. Development of various training programs through which various skill sets and activities of the staff members are targeted for improvement requires planning and proper study of the skill area they lack in.

Strategic and Action Plans

Planning a semester requires strategic plans. Strategic plans of a faculty are those activities and goals the faculty plans on achieving in long terms. Highlights of the current version of the strategic plan are establishment and enhancement of further departments, i.e. Computer Engineering, Computer Education to expand its current Bachelor program as well as offering Master study programs to students in the future. A strategic plan has to be developed based on the current status of the faculty

with a clear view into the future. This plan needs to be developed realistically and it should be in accordance to the Strategic plans of the University and the MoHE. The Action plan is a more detailed and step by step execution of actions within a program or project. The faculty should develop an action plan for each semester where every step is clearly defined and every work load is marked. Existence of such a document helps with the evaluation which then offers a clear picture on the success or failure of plans. That can be avoided in the next semester's action plans compilation and execution. The working groups, committees and departments should all have their action plans and it could be integrated into one united action plan for the whole faculty.

Teaching Plan

Every lecturer attending a lecture session should have a clear plan for what they want to discuss with students in each session. The Syllabi Management process area section in 7.2 is a very good tool that could help with the development of such a plan.

6.3.2 Argument and Explanation

The previous sub-section 6.3.1 lists details of all the items in discussion that require specific attention while planning the semester. These parts are specifically listed in that section to draw attention of the plan developers on major items that need consideration and proper planning. One may need and use various tools and methods when compiling a plan; however, it is necessary to know the aims and reasons for planning.

Estimation is the first step to planning any project. If one looks at the CMMI's standard Project Planning process area, the first Specific Goal of the process area is to Establish Estimates (CMMI 2010b). This specific goal can help with dynamic organizations to have the freedom of development products and choosing the number of students to admit, for instance. However, for the preset — the Faculty of Computer Science — the number of new students to admit is set by the MoHE; the financial means for hiring teachers and buying equipment goes through a long administrative process involving both MoHE and Ministry of Finance. Being a static procedure, the first Specific Goal - Establish Estimates - of the process area is omitted in this analysis. In addition, it is ministries' task to assess this long paper-based work-

ing process. The other two specific goals remaining are chosen since they deal mostly with planning the activities that are supposed to be carried out during the semester execution phase.

The Semester Planning process area formulated in Chapter 7 is a thorough and step by step approach one can consider while planning a semester. It is recommended to use this process area for the compilation of any action and activity plan at each organizational level that the plan is supposed to be developed for. One of the benefits of this process area is that it can be applied to any section, working group, committee or the faculty as a whole. This process area can be used as a check list to remember all the activities need to be gone through while compiling a plan.

Tools such as Critical Path Method (CPM), Program Evaluation and Review Technique (PERT), Resource limited scheduling are examples of standard tools that can support providing the scheduling values. Other tools such as Risk taxonomies, risk assessments, brainstorming, network analysis and quality factor analysis are standard tools that support with how to understand and analyze the challenges. The Work Bench Structure (WBS) and Gantt Charts can be used to identify tasks, their dependencies and finally they can tell us how to structure the semester plan (Chrissis et al. 2011).

Once the semester is planned and the execution time arrives, it is necessary to control the plan's execution and progress. The Semester Monitoring and Control process area serves as a means to support the monitoring and control of the semester execution. To avoid execution difficulties as well as challenges with regard to proper monitoring and control, immediate corrective actions need to be taken to smooth up these procedures.

Monitoring is often seen as a mechanism to criticize one's working habits in the context of the study at hand. No lecturer wants to have his/her teaching plan, syllabus progress reports and their class activity to be monitored by a third person. A lecturer is often a multi-talent, self disciplined, self-centered and powerful person in the class. Any outside monitoring is considered as a challenge in questioning the power and authority of that lecturer. The same mentality applies to the management and leadership. However, monitoring is a good opportunity in letting everyone understand their flaws and concentrate on improving them. The results of mon-

itoring and control process area could also find the candidates for further training and the organization could more intensely focus on its organizational training programs.

To achieve useful results, the neutrality of monitoring process should be kept at all times. The people in charge of monitoring need to look at the issues objectively. Those who are being monitored should consider it as a positive step towards improvement of the whole situation. Thus commitment of the people in applying the plans is necessary and the monitoring and control process area is also examining people's commitment along the way.

The Monitoring and Control process area is designed to find out how good the semester plan's implementation phase is conducted. The monitoring and control process can start parallel to the semester execution or can be carried out at fixed points throughout the semester, depending on the target area. For example, the teaching quality of lecturers can be monitored by observing the teacher's activity plan in the classroom through four to five sessions per semester. The Student's Admission process, which is a one time task per year, can be put under close observation at the beginning of the admission phase. The aim of this process area is to find out the quality of progress in accordance to the given plans.

It is possible to apply the monitoring and control process area in a situation without an earlier division of plans. However, this process is more challenging as no means to apply the process area are given. Monitoring can take place by examining the current situation of the target area and to compare it with the possible outcome. If both don't coincide, monitoring a process cannot be applied successfully.

6.4 Organizational Process Definition & Focus

The Organizational Process Definition (OPD) process area helps with defining the organizational processes, providing guidelines and regulations for those processes indicating how to run the process as well as providing a standard work environment where all organizational employees can work together understanding those processes. The employees can contribute to further development and improvement of those processes when they are asked for their opinion. Once you work for a long pe-

riod with a certain process, you will learn good enough to easily suggest better improvements to them (CMMI 2010b).

The Organizational Process Focus (OPF) main objective is to study the defined processes, gather every stakeholders opinion about them, find the possibilities of improvement, plan for applying those improvements and finally deploy the new and improved process to test in the real working environment under a piloting mechanism strategy. It emphasizes on taking precautionary steps such as parallel execution of the old and new process to avoid any possible conflicting results (CMMI 2010b).
Section 6.4.1 explains the two process areas in further detail in the context of the Computer Science Faculty. To elaborate the effect of the two process areas, a complicated process is explained as an example. The academic staff member's recruitment process. The effect of using the OPD and OPF process areas in defining the example process as well as finding the possible improvements is explained. Furthermore, a number of other processes of the Faculty of Computer Science as an organization are presented. These two process areas could suggest the flaws and strengths of those processes. Using these standard process areas one can find improvement opportunities within processes easily. The processes listed at the end of the section indicate the existence of these processes and process groups in the organization that can be focused on.
Section 6.4.2 discusses the importance of using such standard tools like the OPD and OPF process areas and gives more insight into the activities that are undergone by both process areas. The two process areas are taken jointly because of their close relation to each other. One focuses on the definition of the process and finding solutions to make the process understandable to everyone, whereas the other focuses on the improvement of the process in hand.

6.4.1 Faculty and its Processes

The OPD and the OPF process areas included in this study are two process areas that help an organization define its processes and focus on their improvement. The two process areas can be used parallel to each other at times since the goal of both is to know your organization's processes and focus on finding improvement to them. The questionnaire participants input yielded to the selection and putting these two

process areas together.

The OPD process area requires establishment of the standard processes that run the organization, the development of guidelines and criteria to run those processes and maintaining a standard work environment for all. The working teams need to have clear guidelines on how to run their activities and thus this process area steps in with all its related specific practices and sub-practices to prepare the basis for providing all the necessary explanations to the people who look for answers on organizational issues. In short, this process area requires the definition of all the processes that currently exist and providing guidelines for them.

The OPF process area mostly requires focus on the improvement of a process that exists. The improvement could be calculated with time, monetary costs, speed in production of end result and/or depth of the impact of one process on others. The process area's specific goals asks to find the improvement opportunities by studying the processes, plan and implement process actions to have the process in hand improved and finally deploy the improved process and study the results to what extent it brings improvement to the process execution.

For example, the appointment procedure of a new academic member is clearly stated in the law of MoHE. Let's say a candidate with a Bachelor degree has 75 per cent average of 8 semesters marks, has no failures through out the studies and is 23 years of age (MoHE 2015a). The candidate meets the primary requirements according to the law. There is only one vacancy and some 10 applicants who have applied. The establishment of guidelines proves to be very important at this point since the law is written very abstractly. The guidelines for the appointment procedure tell us about conducting written and oral exams and the one with the highest marks is selected for appointment. The law book and guidelines further define that the appointment process should go through the department, the faculty's board of meeting and finally all the decisions have to be validated, signed and sealed by the Dean of the faculty. After the faculty's procedures are done, the recruitment and promotions committee at the university level verifies the legibility of the documents and checks that all the required hiring documents are present. Then the case is forwarded to the University's general board of meeting and followed by the chancellors validation, signature and seal forwarded to the MoHE for further investigations. There are 18 items in the

final folder that are sent to the MoHE; after approval, this folder returns with two extra items that validate and approve the appointment of this new academic member.

Now considering this just one example, it is a process that has been used for a long period of time, almost since the establishment of universities in Afghanistan in 1967. Is this process well defined? Is it complete and it doesn't need any more improvement? Is there anything else that can be done to this process? The answer to all these questions is YES. We can still improve it. The two process areas from CMMI are exactly there to help in this case. The 18 items that end up in the appointment folder, have no guidelines on how to be obtained. The process definition tells us to look for the existence of such guidelines and details that define the process and help the executor study accordingly. The OPF process area has helped with finding the improvement opportunities; certain steps like the folder being verified at the university level or the verification step at the Faculty's Board of meeting level can be omitted. If the process is properly defined, the folder can be created at the department and signed and approved by the dean and forwarded to the university to be sent to the ministry. Two extra time-consuming steps can be removed.
The following list shows processes that exists in the faculty and could be considered for process improvement:

- Students Registration: A once per year task that is carried out by the administrative staff members of the faculty. The students records are kept forever.
- Students Graduation: A registered student who has completed the course of study successfully and has met all requirements for the bachelor studies needs to go through a process of de-registration. It is basically a sign-off procedure that the student have no liabilities left with the university and can receive their degree.
- Students Performance Records: The exams, their evaluation, marks obtained, credits selected and final results recorded in the credit sheets are a long process that starts with the registration and ends at the de-registration and yields to the students graduation. Documents created throughout this time range have to be kept for as long as the type of the document mandates, i.e. two years for exam

papers.

- Correspondence and Reporting: The letters received, actions taken according to the contents and replies made to them have to be recorded properly and often end at multiple copies in different sections.
- Office Management: The overall activities that yield to management and running of the faculty, i.e. attendance of staff members and report-handling systems, fall into this process.
- Recruitment Procedure: As explained in the earlier example, a complex and long process starts at the availability of vacancy being announced in public media and ends at the recruitment of one person in an academic ranking position. The recruitment of administrative staff is done through the Deputy Chancellors' Office in Financial and Administrative Affairs. The faculty has no official involvement and impact in the recruitment procedure of the administrative employees.
- Working Committees: As described in Chapter 4 there are eight working committees in the Computer Science Faculty. The final activities of these committees always go through the general board of meeting of the faculty and that makes it the 9th working group of the faculty. Every working group has its own processes; some are described in the MoHE guidelines but all need detailed process definitions and focus. Exams, Quality Assurance and Academic Promotions working committees have the highest and time pressured workload.
- Financial Reporting and Procurement: The faculty has no independent financial means to plan the acquisition of the needed resources. Any necessary procurement must be proposed to the Deputy Chancellor's Office in Financial and Administrative Affairs which then processes it. The only report generated in the faculty concerning financial issues is the attendance of the staff members through which their monthly salary is paid.
- Department Officers' Roles and Responsibility: Recruitment, promotions, quality assurance, monitoring the syllabi and curriculum development procedure, controlling and monitoring teaching plans of academic staff, providing

and developing action plans and organizational trainings combine a small part of the roles and responsibilities of the department officer.

This list shows some of the main and standard organizational processes that require close attention for definition, elicitation of those partly defined and focusing on their improvement. Much work could be done in this part; should the organization consider process improvement and take a step towards the realization of this goal, the OPD and OPF process areas are the key point in starting the improvement initiative.

6.4.2 Argument and Explanation

The two process areas taken from the Standard CMMI's Development frame work (CMMI 2010b) that is, the OPD and the OPF, can serve as a thorough checklist for finding missing points in the standard processes within the organization.
The processes introduced in the previous section 6.4.1 all match the definitions set by the OPD process area. Any process can be matched to the requirements set at the OPD process area to find out the missing points at each process area. These flaws often have one common point; they are not documented. If you ask an experienced member of the university who has worked with that process for years, they can easily tell you how to do the task. But, when it comes to the introduction and provision of documents, they fail. The processes have been defined over the years through individual letters, but finding those paper based letters from an archive is a time consuming task on its own. A properly documented process definition could be always useful.
One of the points an OPD process area can concentrate on is providing documentation. The establishment of proper documentation is a continuous sub-practice in almost every specific goal and specific practice of these two process areas. The OPD helps with giving documents to all those defined processes. It requires the collection of guidelines and building a working environment which every member can learn from and can have as a documented point of reference.
Once processes are understood, found out and well defined to the organization and the employees, it is time to focus on how to improve those processes. Examples are

the removal of duplicated and redundant work points and unnecessary steps are to be avoided through the process execution. When the organization comes to this step of potential improvement, the OPF process area comes in handy, because its specific goals and best practices help the process improvement initiative to focus on finding those avoidable steps.

The OPF process area concentrates on the evaluation of a process mainly to find possible improvement opportunities. In this step, the process area looks at the nature of the organization and the type of processes that run it. Followed by this fact finding mission, the processes are checked against the current and available standards. This presents an idea about the strengths and weaknesses of the processes under study. The strengths could be further used and the weaknesses could be identified and addressed for enhancement purposes. As stated earlier, the process improvement criteria includes aspects that address the needs of the organization. If a process is supposed to be done in shorter time, then time is the price to obtain. If the target is to improve a lecturer's teaching skills, the quality of teaching in this one is the final price for this effort. For each process the desired changes and achievements need to be defined in details.

Upon close study of the current processes and their flaws, the OPF requires the creation of action plans that result in the implementation of those potential improvements. Not all the processes can be easily improved as there are several stakeholders involved; therefore, while devising the action plans, all involved parties must be considered. For example, if the verification of recruitment should be reduced to only department, faculty dean and chancellor, those changes require the negotiation and justification of the Cohesion of Academic Affairs and Promotions Department at the MoHE. This time for correspondence and justification should also be reflected upon and calculated while implementing the plan.

Finally, the new and improved processes ought to be run. The results should be noted down and the experience has to be studied. A pilot period of deployment of a new process should be considered. If the new changes yield to further errors and less accuracy, there should be the possibility of rolling back. If the changes comply to the new situation, time is saved, accuracy is increased, then the improvement goal is achieved and the new work progress could be benefited from. During the piloting period the

old process needs to be run in parallel, depending on the nature and sensitivity of the process. It is worth mentioning that both process areas discussed in here find themselves at Capability Level 1.

6.5 Process Quality Assurance

Quality is a relative term. When quality of a certain task or entity is discussed, we need to know what we are comparing it to. The quality assurance team in the faculty focuses its evaluation work on two sections — the academic and the administration sections. The academic section evaluates the teaching methods, teaching material and contents of the subjects offered to students. This is mostly conducted through students by filling out anonymous questionnaires. MoHE have set a regulation that only students who have previously earned an average mark of 70 per cent and above can take part in filling out the questionnaire. The argument for this regulation is that those students can provide feedback more objectively as they have a higher understanding of the course. However, due to the high number of students attending one course, this regulation is often overlooked and almost everyone gets to express their opinion. The management section collects questionnaires filled out by the leadership and those in charge of management tasks within the faculty, such as dean, deputy dean, head of departments and employees of students affairs' office. The quality assurance initiative is administered through a central body at the MoHE. The primary objective of this body is to prepare universities around the country to gain international accreditation. They started the process with self evaluation mechanisms introduced to the universities, with a goal to follow it up with peer-university reviews and at much later stages having third party independent bodies to do the evaluation. The self evaluation reports are then collected and used as a basis for peer reviews. The peer reviews are conducted through members of other partner universities*. The follow up steps would have been the review of certain qualified universities by international quality assurance organization as an external audit. Details of the approach to this initiative is private to the administering body and no one can know what their plans are and how they are going to realize their plans in the future. Since it is a performed process, thus the current capability level is 1 and there

*No specific university or evaluation bodies were introduced at the time of writing of this work

is plenty of room to improve.

Quality assurance activities require trained quality assurance experts. Trainings can be provided* for those who run the quality assurance activities. It is recommended to separate the people implementing quality assurance from the people who are running the task itself. This process area should run periodically, and thus to ensure quality of the services including teaching. This process area is applied to the evaluation of semester activities, syllabus management and organizational activities associated to the execution of plans within a faculty.

The quality of work can be assessed in various ways, such as daily feedback of colleagues through a normal chat or through more formal methods such as structured interviews and questionnaires filled by colleagues and/or students. The formal methods require more time due to information gathering and analysis, the representation in terms of graphs, numbers or reports. The end result depends on the depth of the study and as well as the analysis. However, quality assurance is a key aspect in academia and requires constant assessment and improvement.

The quality assurance initiative in the faculty tries exactly to find flaws and analyze what is missing within the structure and documents. It tries to compensate those flaws by providing feedback on their development mechanisms accordingly. The Process Quality Assurance process area introduced in this work acts basically as a support to the current initiative that has been started by the MoHE and tries to outline other points of focus that need this initiative's immediate action. Furthermore, this process area can be used as a unique mechanism for internal audit and quality assurance procedure to help the people in charge of auditing and the management to find the challenges more easily. It can be used as a supportive source to prepare the grounds for the quality assurance initiative and meanwhile provide faster feedback to the management.

This process area is not in conflict to the quality assurance initiative of the university as well as the faculty and in fact supports the initiative by providing supporting ideas. This process area indeed emphasizes on the objectivity of the quality assurance with the objective evaluation and observation of the tasks and entities with a main focus on enhancement quality and error detection.

*Refer to Chapter 7, section 7.9 for further insights into the matter

6.6 Organizational Training

The Computer Science Faculty as an educational organization is at its developing phase and needs to hire staff members to be able to meet its operational goals in short term and its strategic goals in the long run. All employees need special academic and administrative trainings. This fact and the need for such trainings were also highlighted by the participants of the questionnaire as well.

The Organizational Training (OT) process area is designed to help organizations with understanding their training needs, planning them accordingly and provide training opportunities to their staff members. The following section 6.6.1 explains the training need in the Faculty of Computer Science in specific areas. The use of this process area can support the identification of the training needs, conducting a proper training plan and developing training capabilities within the faculty.

6.6.1 Training Needs

Everyone working at the faculty needs to receive office management and administrative trainings. An academic member also has an administrative role and thus is required to know and be able to carry out the related tasks such as tasks related to department officer or member of a working group. The training capability that enables the staff members to perform administrative processes is necessary to be developed within the faculty.

Teaching is a didactic task assigned to the lecturers. Not everyone takes didactic courses during their Bachelor or Master study programs. Thus, the establishment of a training program to enhance lecturers' teaching competence is essential. Such a training should cover all teaching aspects such as syllabi development, devising teaching plans, holding a lecture, methods, pedagogical studies, preparing exams for students, communications and soft skill management.

The long term goal of the faculty is to offer students with a chance in pursuing a Master degree program in Afghanistan. The MoHE laws and regulations allow an educational entity to offer a Master study program only in the presence of enough qualified lecturers with PhD degrees. The minimum number has been set to be at least three PhD holders and one member with a terminal rank of Pohandoy (MoHE

2015a). That enables a faculty to offer a Master degree program only in one major. The development of such a study program requires proper planning to provide the current staff members with opportunities on gaining a PhD degree. Currently this cannot be realized within Afghanistan; thus, staff members need to travel abroad to pursue certain PhD degree programmes.

Currently, being at Capability Level 1 in the Faculty of Computer Science, the OT process area helps an organization to focus on taking action concerning the provision of staff training. The specific goals and specific practices along with their relevant sub-practices are all a supportive tool that gives a clear insight to the organization on developing a training capability within the organization. The better trained staff members always yield to a smoother execution of processes and the end result tends to be better normally.

OT requires the organization to investigate long term needs and to carry out an assessment of what kind of activities to get involved in the future. This assessment includes knowing and understanding the current skills and abilities of staff members. The training responsibility should be specified. Organizations are to provide the kind of trainings and manage them within smaller working groups. In the study at hand, planning and offering trainings in didactic is the responsibility of departments whereas providing the facilities for Master degrees and PhD qualifications is the responsibility of the faculty.

Once the training is specified, execution plans need to be conducted. The decision on whether the training need be taken in the organization or it should be outsourced to third party organizations has to be taken. This plan needs to consider how to compensate the organizational operations when employees are sent off for training. The plan should consider the running processes; the semester execution and other related activities should not be interrupted. The faculty ought to consider the development of a training capability with the organization. Outsourcing trainings can be costly to the organization in a long term.

OT process area takes the necessary steps to provide training to the staff members and watches the training results over the work performance. The training results should be observed by the ones in charge of the process improvement initiative closely. The training material should be kept for future use in trainings for new recruitment

but also updated to new methods, studies and laws.

6.7 Summary

CMMI being originally built for Software Development environments has passed more than 20 years of its life-cycle; with the most recent updated official release of version 2.0 in 2018. Due to its openness numerous scientists adapted this model into different (business) areas with the goal of process improvement. These cases include, among others for example financial systems, the automotive industry, information technology security, aviation as well as education systems.
This chapter paved the way for the next chapter (Chapter 7) where nine process areas of the CMMI Development model have been chosen and customized. This chapter dealt with the analysis and findings of previous chapters where the outcome of the Questionnaires were assessed. The topics discussed in this chapter are mainly backed-up with the findings from the participants input the semi-structure questionnaire that is explained in Chapter 4 and discussed in Chapter 5.
In this chapter each process area is either taken separately or grouped together when relevant, i.e. Organizational Process Definition and Organizational Process Focus, then analyzed and discussed which was backed-up by the findings from previous chapter. The relevant process area's needs and target of application is explained in further details and examples provided. The current situation concerning the relevant process area in the actual working environment at the faculty is tackled and points that need to be considered while applying the process enhancement initiative is further explained. Chapter 7 is a complementary framework for Chapter 6. In this chapter you read what process areas to deal with at the target organization and what stuff needs to be prepared. The coming chapter, (Chapter 7) one would get to read a framework definition in close terminology to the nature of the organization to boost up the initiative.

7

Simplified CMMI in Example of an IT Education Institution

Chapter 7 introduces the readers to a number of important process areas that require special attention, follow up and implementation to improve the quality of study program at the IT Educational institutions. The educational institution at this discussion is the Faculty of Computer Science at Herat University. It is a state-run educational institution that works after higher education rules and regulations. Before moving forward into details of each section a brief and abstract explanation is in order. As described earlier in Section (4.3.1) of Chapter (4), Department is a central entity of a Faculty within a University, which is in charge of bringing about any changes in the educational section. The actual physical work takes place in this core unit. The students management, lectures arrangement, development of study material, syllabus and curriculum, staff members recruitments, research, promotion, and disqualification of lecturers are administered through this entity. A Department is the main working engine and the main functioning unit of a faculty, where the faculty is merely a political representation within the university and through the university within the Ministry of Higher Education in Afghanistan.

Educational development and improvement must happen and initiate within the core of the system. All the stakeholders, be it external such as administrative employees of the Faculty who deal with the Department, or internal such as the permanent department members (i.e Lecturers and Assistants) and the students get affected directly by how good or bad this educational unit functions. Therefore, all the following sections, which generate the core focus of the study at hand, target the main processes and functions that get executed at this unit.

In this work functions such as students enrollment which is an important process and needs high attention for improvement has not been considered. The enrollment procedure is a highly complex process that involves Ministry of Education and Ministry of Higher Education and is administered by a central body, the National Kankur Committee, in the capital city of the country. This part always is a huge challenge and often leaves the departments with a surprise at the beginning of each new batch of new comers. As the number of students requested for the new batch is always five times lower than the number of actual students introduced for enrollment. For more details on Kankur or the University Entrance Exam please refer to Section (2.3) in Chapter (2). Improvement for this process requires a general reform in the Education system and furthermore within the Kankur examination system. This is an open challenge for the whole process improvement initiative that might undergo at a department.

As for the study at hand, the organization is considered to be at Maturity Level 1. Organizations at this level (Maturity Level 1:Initial) deal with Processes in an ad hoc and chaotic manner. The Processes are partially defined and they are running somewhat to get the job done. Success in organizations with this Maturity level 1 depends on the competence and heroics of the people in the organization and not on the proven processes (CMMI 2010b). The definition of Maturity Level 1, statements and findings of the questionnaires backs up this statement.

If we look at the processes and process areas within this organization separately - a process based approach also known as the Continues approach by the CMMI - then the analysis of the questionnaires show that most of the processes have earned Capability Level 0:Incomplete and Capability Level 1: Performed. A process is considered Incomplete (Capability Level 0) when it is either not performed at all or is partially

performed. Such processes often lack one or more specific goals or no generic goals exist for them, hence there is no need to be Capability such process (CMMI 2010b). As an example one could point to the financial independence and income generation processes. Since the nature of the organization being a government entity allows no income generation, therefore processes involved in such activities are not performed yet. As of the rest of the known processes found and discussed in chapters 4 and 5; those processes are considered to have a Capability Level 1: Performed. As per the definition of this level a process that accomplishes the needed work to produce work products and satisfies its specific goals, then the process is considered to have reached the Capability level (CMMI 2010b).

These departments have existed and been functioning using known practices so far since the beginning of their foundation. Just to consider the example of Herat University's Computer Science faculty, it has been more than 15 year since its establishment. The departments are active and producing results ever since. The processes are in place and somewhat defined. Their achievements being also reflected in the answers of the questionnaire participants brings them as an organization at Maturity Level 1 and their processes, if investigated alone, at Capability Level 1. Since the definition of Capability Level 0 and Capability Level 1 processes also confirms that we have some processes in hand, they exist, partially implemented and the organization runs and tries to meet the ends, therefore, with these definitions kept in mind, the author considered and have based this work to target the process areas on reaching Capability Level 2 and on wards. All the following sections — should the process improvement take place successfully — indicate the relevant level. At the moment there is a lot of work to be carried out for reaching Capability Level 2 and 3 and thus most of the important process areas that have been picked up in this work considers the initial goals of improvements to reach at Capability levels 2 and 3. Process is the core factor for improvement within the CMMI framework. The organizational activities are divided into Process Areas to give a focused view point for the organizations that want to improve their processes. In the following sections the readers will go through a number of process areas that are selected and customized according to the nature of the organization. The study at hand has based the work in Computer Science Faculty - an IT Education Institution at Herat University. The

analysis of the questionnaires have helped the author pick these process areas to consider for further improvement. The CMMI's template for explaining the process areas is mainly used, even the terminology and language pattern is used almost the same. However, this does not mean an exact use of the whole template for each process area. The chosen process areas that match the structures of the current study's setup are adopted from the CMMI's Framework and an attempt to simplify it for the nature of the IT-Educational institutions in Afghanistan is made. For example the Semester Planning process area in this work resembles the CMMI's "Project Planning" process area. Challenges, shortages, overlooking or undermining the importance of certain activities as discussed in previous chapters are mostly the main reasons behind the selection of the following process areas in this work. The author believes these points must be improved continually so that the ideal IT Education can be offered to the students.

A complete analysis and explanation of why these process areas are selected were already presented in chapters 5 and 6. Here we focus only on what aspects and process areas have to be considered for improvement and given the CMMI's framework template, the question "What" to be improved is answered. The answer to "Why" those specific process areas needs more attention within the faculty along with more details and explanation is already discussed.

In Chapter 7 each section holds the explanation and "the what to be done" for each process area. Furthermore you would read SG (Specific Goals) as sub-sections for each process areas and SP (Specific Practices) as sub-sections of each Specific Goal (SG). Within Specific Practices (SP) you would mostly read a list of sub-practices that give further hints on points to be done while applying that specific practice.

The first five sections of this chapter prepares the organization for achieving Maturity Level 2:Managed and the later four sections targets preparing the organization to reach Maturity Level 3:Defined. Maturity Levels 4:Quantitavely Managed and Maturity Level 5:Optimizing are not considered since the organization is not ready for those kind of evaluation yet.

However, if the following identified process areas are addressed separately and their processes are evaluated and under go process improvements then one would consider capability improvement and use the Continues approach to reach the desired

Capability levels in each process area individually. Having the possibility to consider improving an entire organization reaching the desired Maturity Levels or just focusing into specific process area to reach the desired Capability levels is among the main points that makes CMMI for process improvement so appealing. One can decide according to the amount of resources that is available and needed to be invested in the process improvement initiative within the organization. (CMMI 2010b)

7.1 Requirements Management

Purpose
The purpose of this process area is to manage the requirements of the semester plan and ensure alignment between the requirements and the plans during which the services of the faculty is offered to the students.
Introductory Notes
All the requirements whether they are technical or nontechnical that are needed for running a potential good semester are managed by the Requirements Management process area. If you have implemented the Requirements Development process area, the products that are generated by its processes are also managed by this process area. Through out this two process areas, should you encounter the term "product", then it means the services, systems helping with the services their components, semester action plan, teaching plan, methods and anything that relates to IT education. We need to make sure the semester execution and planning receive the approved requirements. Documentation is one important part of the requirements management and changes.
As the results of the questionnaire were discussed and elaborated in Chapters 5 and 6, one can see a clear pattern that the study setup has achieved a Capability level 1 in this process area. The requirements are identified and collected according to the known methods to the current members. The improvements and institutionalization of processes within this process area prepares the organization towards achieving Maturity Level 2 on the organizational level.

7.1.1 SG 1 Manage Requirements

The focus of this specific goal is to collect, analyze and identify any inconsistencies between the semester plan and work product requirements. It is strongly recommended to manage all change requirements through out the semester while keeping a clear relationship between requirements, semester plans and work products. If there are any discrepancies, corrective measures should be considered immediately. When starting a new study program i.e. a Master Study Program at Computer Science Faculty of Herat University, it should be definitely considered.

7.1.1.1 SP 1.1 Understand Requirements

The educational institutions offer several study programs and subjects within a study program every semester and they all have requirements that has to be understood and in order to execute the plan, those requirements are necessary. It is necessary to establish an official channel through which requirements are provided. The work products produced by this specific practice would be lists of criteria for distinguishing appropriate requirement providers. One needs something, then they should know whom to talk to and where to find his/her contact details. This list helps with such information. The criteria should be analyzed and a set of approved requirements are the end results of this specific practice.

Subpractices

1. Establish criteria to know your providers of the requirements
2. Establish objective criteria for evaluating the criteria, accepting or rejecting the requirements.
3. Analyze the requirements to make sure they are necessary for the product
4. Should the requirements depend on external or internal sources, it is necessary to come into an agreement with the requirements providers so that the semester participants can commit to their tasks accordingly

7.1.1.2 SP 1.2 Obtain Commitment to Requirements

The semester participants need to commit to the requirements and should it be necessary, they should provide to the requirements. This specific practice focuses on gaining agreements and commitment of those who are actually doing the job to implement the requirements. As it is clear the semester can evolve under various circumstances in different ways and so does the requirements. Therefore, this specific practice makes sure the participants stay committed to the current and approved requirements. Requirements impact assessments as well as documented commitments to requirements and requirements changes are the end results of this specific practice.

Subpractices

1. Assess the impact of requirements on existing commitments
   If the requirements change, we need to evaluate the impact of the change requirements on the semester participants. Do they loose a lot? Do we go way below the vision of our semester plan? This impact should be studied and analyzed.

2. Commitments need to be negotiated and recorded
   In the event of changes new commitments should be negotiated with the requirements providers so we are sure the participant stays committed to the plan.

7.1.1.3 SP 1.3 Manage Requirement Changes

As the semester progresses and more changes evolve, those changes to the requirements should be also managed. There are a number of reasons for requirements to change. The semester's needs might change or the work progress need different requirements, in any case the requirements will need to be changed. To manage those changes efficiently and effectively without causing any over heads, those changes need to be managed systematically. For better analysis, it is always a good practice to know the source for enforcing the change. It should be also well documented. Requirements change requests, requirements change impact reports, requirements status and requirement database are parts of the end results of this specific practice.

Subpractices

1. All requirements and requirement changes must be documented
2. Keep a requirements change history with their justification
3. Evaluate the impact of change requirements
4. Requirement and change data should be made available to the whole semester

7.1.1.4 SP 1.4 Ensure Alignment Between Semester Work and Requirements

We have to keep the semester plan and work products aligned with the requirements. The focus of this specific practice is to figure out inconsistencies between requirements and semester plan and work products. When inconsistencies are found, this specific practice throws corrective actions to resolve the issue. The end product of this specific practice would be a detailed documentation of all the inconsistencies found and a corrective actions document.

Subpractices

1. Review semester plans, activities and work products for consistency with requirements
2. If there was any inconsistencies, identify the source
3. Identify any changes necessary to be made to the plans
4. Launch the necessary corrective measures to fix the issue

7.2 Syllabi Management

Purpose

The purpose of Syllabi Management process area is to develop, indicate and maintain contents of a subject using certain identification, controlling, accounting and auditing methods to make sure contents of a course is planned completely and organized as a deliverable product to the customer (students).

Introductory Notes

Syllabus development is a Department centric activity often carried out by individuals who are responsible to teach the subject and controlled through a joint commission meeting within the Department. A Syllabus requires to demonstrate details of the contents of the subject being taught which is also associated to a fixed time plan. It is a detailed work plan for a lecturer, where contents of each session is indicated, exams are highlighted and is in association with the semester plan.

This process area is considered as one of the continual activities within an educational institution. As participants of the questionnaire have stated, each entity handles this process area differently, since this process area deals with continual updating of the teaching material. The study setup and participants have indicated that the faculty has established a mechanism to handle this properly. Hence have acquired the Capability Level 1. A process with capability level 1 needs to be further improved to get the process area and its processes hold a firm grounds. Applying this specific goals and practices that are presented in the following sections would help the organization reach a Maturity Level 2.
The following activities should be considered while working with this process area(Chrissis et al. 2011):

- Identifying the structure of a selected subject to give clear baselines at given points of time
- Controlling changes to the syllabi items
- Building or providing specifications to build syllabus from a central syllabus management system
- Keeping control over the baselines

Contents which fall into the Syllabus Management are basically the end product that is supposed to be delivered to students together with all the required tools whether hardware or software and other extra resources that would help students understand the topic of the subject better. A baseline in Syllabi Management process area is a point in time that serves as a basis for continuous evolution of the syllabus progress. The Syllabi Management process area focuses on controlling the technical

and managerial contents of a subject. Every session a lecturer approaches a class environment is formulated in advance, with what is supposed to be done.

7.2.1 SG 1 Establish The Syllabus Management System

Every subject is a work product and it is important to establish baselines for each subject. Baselines help you with organization of the lecture contents and thus makes it easier to plan against the time. It is important to keep in mind duration of a semester is 16 weeks and that includes the time for exams, public holidays and special unpredictable mostly unfortunate events that can disturb the execution plans. Therefore, establishment of clear baselines is very important. The following two specific practices deal with maintenance of the baselines and checking the integrity of the baselines.

7.2.1.1 SP 1.1 Identify Syllabus Items

The first specific practice to this specific goal requires us to find the syllabus items, components and other related products so they can all be placed under the syllabus management. The syllabus identification requires us to select and specify the subject that is supposed to be delivered to the students, its contents, needed resources and tools as well as the items necessary for understanding and defining the subject better. The syllabus items could be hardware and equipment as well as software items, books and scripts. The outcome of this specific practice would be syllabus items that are identified for use within a subject.
Subpractices

1. Select the items that help setup a working teaching environment for your subject.
2. Assigning unique identifiers and IDs to your items helps with tracking and monitoring. It is a good practice.
3. Each syllabus item's importance should be outlined so that it would help the Semester planning, in case the item not be available.
4. Specify each item when they are needed and when is their execution time

5. Should an item be shared among several entities, identify the owner and the sharing management mechanism

7.2.1.2 SP 1.2 Establish a Syllabus Management System

We need to have a Syllabus Management System together with a change management system to control and keep an eye on the variation of the syllabus contents over time. Such a system would be storing the whole syllabus for each subject, their relationship and would give ease of access, use and edit when something is required to change. The end product of this specific practice would be a unique database that helps with the syllabus management and tracking of changes of each subject's syllabus.

Subpractices

1. Establish a Multi-level control mechanism
   It is often seen that lecturers who teach a subject remove topics from the syllabus based on personal taste or lack of ability to teach that specific topic. This removal yields to students' lack of knowledge improvement and missing competence, since the following semester's subject is based on these topics, they fail to learn or perform as expected. Therefore, a level controlling mechanism should be applied so no one can edit contents of the syllabus based on their personal deficiencies and should use the knowledge and skills improvement chances provided for them.
2. Provide access control to make sure only authorized people can make changes to the system
3. Store and retrieve syllabus items in a syllabus management system
4. Share and transfer syllabus items between control levels within the syllabus management system
5. Store, update and retrieve syllabus management records
6. Preserve the contents of the Syllabus management system and make a version control to keep the older versions for future comparisons
7. Revise the syllabus management structure as necessary

7.2.2 SG 2 Track and Control Changes

A syllabus requires regular update to make sure students receive the latest information on the subject. Plus it is also important to be able to look back at the changes at some point to evaluate the progress and evolution of the subject. The specific practices of this specific goal help with keeping an eye on the changes and putting mechanisms to control those changes.

7.2.2.1 SP 2.1 Track Change Requests

Changes come whether with time or with noticing failures within the subject's implementation. Therefore, a mechanism that tracks those change requests submitted by the lecturers or seldom suggested by students should be attended properly. The change requests will then be analyzed to see how much do they affect the normal flow of the subject in discussion.
Subpractices

1. Initiate and record change requests in the syllabus management system
2. Analyze the effect of the changes and the potential fixes that come a long with the change request
   Consistency of the changes in comparison to the actual contents of the syllabus is analyzed. It has to be evaluated to see those changes can bring an improvement to the contents or are those changes considered to reduces quality and future competence of the students. The dependency of subjects should be also considered while analyzing the change.
3. Prioritize change requests
   During a semester execution, it is necessary to evaluate the importance to those changes. Should those change requests be applied immediately on the subject, or can they wait for the next semester. It is important to know the priority of the change and later on apply accordingly.
4. Review change requests together with the committee
   The change requests should be reviewed and discussed with all committee members to get everyone's opinion on the change. This also can help with the effects

the change might have on other dependent subjects. It is a common practice to record the effect of each change request, the justification for bringing those changes including the success and improvement of the subjects implementation and when necessary a brief action plan to integrate those changes within the subject.

5. Track the status of the change requests to closure
   The change requests should be handled efficiently and on time. Once a change request is approved, it is important to integrate the change within the subject and apply it so the students can use the most out of the new changes and such a change request would also come to an end.

7.2.2.2 SP 2.2 Control Syllabus Items

This specific practice requires us to keep an eye on the previous syllabus contents and control the changes that have been approved and processed. The controlling process requires keeping track of syllabus items and updating the baseline. A revision history of the items as well as archives of the older versions of the syllabus would be an outcome of this specific practice.
Subpractices

1. The changes should be controlled during the whole semester
2. Should it be necessary; gain the authorization before changes are made to the syllabus management system
   This can be applied as a level of control in the Syllabus management system, where authorized bodies will be requested to review the changes and approve them for entering the system for further use.
3. The changes should be checked-in or checked-out within the Syllabus Management System
   If a change request has not been approved by authorized bodies, such a change request has to be checked-out. This way the integrity and correctness of the syllabus items are preserved.

4. Make sure that the new changes does not compromise the quality of the syllabus on its own as well as in comparison to other dependent subjects
5. Devise a schedule for the new change
   Consider a change request has been approved and thus it requires a schedule and proper plan to integrate the change. Apply all the necessary checks and reviews and finally to make sure the subject's new syllabus is updated and applicable and ready for use in the classroom.

7.2.3 SG 3 Establish Integrity

This specific goal requires establishment and maintenance of the integrity of the Syllabus Management System through out the process area's use and application. This specific goal focuses on the integrity of the whole system together.

7.2.3.1 SP 3.1 Establish Syllabus Management Records

It is important to build lists and logs to record description of syllabus items. The example of such lists would be revision history of the syllabus items, the change log, change request records and the status of the items. These are just example products that would deal with this specific practice and bring about the means for understanding the syllabus, its changes over the course of time and how far has it been updated.
Subpractices

1. Record the actions with sufficient details
2. Provide access to the relevant stakeholders who work with or get affected by contents of the syllabus
3. Use the versioning system for your works reviews
4. Always confirm the consistency, correctness and completeness of items
5. Confirm syllabus changes are adoptable by the procedures and standards in use
6. Track the items from supervision to closure
7. Document the process

7.3 Semester Planning

Purpose

The purpose of Semester Planning is to plan semester activities properly.

Introductory Notes

The success and improvement of a semester activity directly depends on how you plan for it. In environments where several external sources are directly impacting the execution of a process, one needs proper planning with enough contingencies in order to maintain a good flow of the events.

As also discussed in earlier chapters, the educational entities in Afghanistan have different approaches to conducting plans. If focus is put on improving this specific process area, then it would help the organization reach a Maturity Level 2.

While planning a semester the following points are of high importance to be considered (Chrissis et al. 2011):

- Developing a Semester Plan
- Interacting with relevant stakeholders
- Getting commitment to the plan
- Maintaining the plan.

Planning a semester requires estimation of work load for the semester activities for both staff members and students, figuring out the needed resources, fixing the schedule, finding out the probable risks that would disturb the flow of the semester activities and its counter solutions. Existence of such a plan can help with the controlling and monitoring the process at a later stage and one can evaluate the current situation in comparison to an existing plan. This plan can be organized in one single document for the whole process area or can be minimized into smaller parts for each section, staff member, subject to be taught or work activity separately. In a semester plan, each member's role must be clearly indicated and it should have no ambiguity on who is supposed to run a task. When planning a semester, one should know its organization, the funding resources, the availability of staff members and the requirements should identify all the necessary parameters that are needed to plan

the semester. These parameters are all the information that is needed to plan, organize, direct, coordinate and report. As funding a semester is an internal process and in terms of the administration system in Afghanistan, it is a very static procedure, therefore, the financial part has not been considered in this work. The financial plans are generated through the Vice-Chancellors Office in Administration and Financial Affairs. The faculties can preset their material wishes in form of material requests, all other financial aspects of semester plan such as staff salaries are predefined and pre-organized by the University and the MoHE.

7.3.1 SG 1 Develop a Semester Plan

In order to run a flawless semester, it is needed to have established and maintained a proper semester plan that covers all aspects of the semester activities. Such a plan can be verified and approved through the Department Council and later through the Faculty Council since the end result would be an official document that would be used to run all the relevant semester activities. Planning requires involvement of all stakeholders. The semester plan should make it possible that all plans required for a smooth semester execution is in agreement with the overall educational program and goal of the faculty.

7.3.1.1 SP 1.1 Establish the Schedule

Each semester is consisted of 16 weeks. This time range should be divided properly so that all stakeholders can benefit from the resources equally. There is a huge challenge in front of this specific practice. The resources are limited and the demand is high. The time, PC-Pools and class rooms should be scheduled so that all students can use them properly. The outcome of this specific practice would be production of semester schedules, exam schedules and staff members activities schedule.
Subpractices

1. Identify Major Milestones
   For a successful schedule planning, it is required to know end of the tasks and the points where a certain task has to be finished. Time is a sensitive issue and that is why every lecturer and stakeholder's task should be clarified with clear

milestones. Teaching plan is another part of the scheduling task that has to be harmonized with the rest of the schedules. Building a teaching plan as part of the Syllabi Management is a parallel sub-practice that goes a long with this specific practice.

2. Identify Schedule Assumptions
   While devising a schedule, there are often obstacles that affect a proper planning procedure. These kind of obstacles has to be clearly figured out and marked out. As an example, there are a lot of public holidays with religious roots that are devised from the Islamic calendar and there is +/- one day margin of error, as the date changes after the circulation of the moon around the earth. Identification of such points in the schedule and planning part helps the executor to react accordingly.

3. Identify constraints
   External constraints such as resources, absence of staff members through out the semester, require attention. Since, such constraints can greatly affect the execution process of the semester as well as the creation of schedule.

4. Identify task dependencies
   Several tasks are running through out the semester and their order can affect the end result. Therefore, it is important to specify the relationship and order of tasks within each other. Some can be executed in a linear fashion whereas some might be planned parallel to each other.

5. Establish Corrective Action
   A schedule should be managed dynamically, specially in uncertain situations. The schedule should be established in a way that provides facilities for taking correctional actions when required. This aspect of the scheduling allows easy adaptability during the execution, however, should the affecting factor be too strong, will definitely change the course of the plan execution and may require re-planning.

7.3.1.2 SP 1.2 Identify Challenges

Since state-run IT educational institutions in Afghanistan are highly static in terms of structure and are not threatened by many business closures or supplier failures, therefore it would make more sense to switch the word risk with the word challenge. Despite the static structure of the entity, challenges are very common to its execution efforts. It is important to identify those challenges through out the planning process so that when faced, an instant solution can be devised or the plan executioners could react to the challenge more prepared. The results of this specific practice would have identified challenges, their impact as well as the probability of them occurring to their priorities.

Subpractices

1. Identify Challenges

   This sub-practice involves all those activities that highlights and finds out the risks, hazards, vulnerabilities, shortages, lack of resources and anything that would leave a smooth execution of the semester run into a problem is considered as a challenge. The challenges must be figured out and clearly explained so that in the analysis part, it would help the decision makers take proper decisions in removing the challenge. We could use certain standard methods such as Risk taxonomies, risk assessments, checklists, brainstorming and quality network to understand and analyze challenges.

2. Document Challenges

   A common mistake often seen in the administration system of most educational and non educational institutions in Afghanistan is missing out on documentations. Even though, they are legally bind to document any such event for future conflict resolution issues, but still employees tend to neglect this practice. It is important to keep a clear track and to document all the challenges, with every possible details that they could find about them. This way you could always return to and learn from past challenges.

3. Monitor Challenges

   Once challenges are identified and documented, it is always important to keep an eye on them. Do they get solved with the precautionary methods taken? Are

they still remaining and turning into a problem? Do they repeat themselves in the future? These are some questions one could keep in mind to understand the challenges and should it be necessary revise those challenges and find newer methods to face them. It is important to talk to the relevant parties involved with the challenge as well as with the solution of the challenge. This constant monitoring would require revision of the challenge documentations. Such constant revisions would help change the status as well as the priority of the challenge.

7.3.1.3 SP 1.3 Plan Data Management

Data are an essential part of the semester's execution. They are generated, handled and provided by different sections of an educational institutions in different amounts and forms. They have various forms such as reports, manuals, scripts, charts, drawings, files, students registration forms, log books, letters, students marks and they can be presented and or stored on different mediums. It is important to collect all these data, store them properly for future references, and define a clear privacy and access control. A Data Management plan, list of managed data, privacy requirements, security requirements and procedures as well as list of data to be collected are part of main example products for this specific practice.

Subpractices

1. Establish requirements and procedures to ensure privacy and security of data
   It is very important to put restrictions on who is allowed to have access to the semester data. Therefore, a clear controlling mechanism that defines the legibility of users for accessing the data has to be devised and put into action. The archiving mechanism of the old data and the daily access to current and archived data must be secured at all times.

2. Determine the semester data to be identified, collected and distributed
   Students records, staff members records and participation reports, meeting minutes, activity reports are just a number of examples that must be identified for each section, committee and department within the educational institution.

3. Determine the requirements to access and distribution of data to the relevant stakeholders
   Since there are several external entities also involved in the semester execution, therefore, a clear mechanism that states who receives the data on the external side of the institution is mandatory and required. However, as for the internal members, clear access restrictions have to be granted to the members. This might be difficult on the legacy based systems, where storage mediums are mostly log books and folders, but this can be still controlled through a third person supervision.

7.3.1.4 SP 1.4 Plan Resources

One of the most important specific practices is resource planning. This needs specially more care and planning since shortage and/or lack of resources is a huge challenge to the planner. Hence, makes it more crucial to plan the available resources properly. A good practice to this would be using a WBS (Work Breakdown Structure) with each task being given a unique ID for tracking. It is also advised to build a WBS dictionary where each work item has been explained. This helps a lot in understanding the tasks properly.

Subpractices

1. Determine process requirements
   It is important to identify all processes that contribute to the proper management of the semester. They need to be defined and coordinated in accordance to the relevant stakeholders requirements. Identification of these requirements helps with knowing what we have in hand, what is limited and what should be further worked on to be provided for a smooth semester execution.

2. Determine communication requirements
   Miscommunication is often the basis for a lot of troubles and therefore, establishing a clear communication channel with all the involved parties is important. Every stakeholder should be able to communicate their needs and discuss possible solutions with each other.

3. Determine staffing requirement

It is relevant and important to know your available personnel and should one require more staffing, it should be planned well ahead of time. There are several parallel tasks each staff member should carry out during the semester and these tasks should be clearly assigned and the person in charge must stand responsible for its execution.

4. Determine facility, equipment and component requirements
   Next to staffing requirements that is essential for a smooth semester execution, it is important to plan for all other physical and non physical resources. It can be classrooms, PC-Pools, library resources and the usage time and opening hours of the library.

5. Determine other continuing resource requirements
   Other items such as power, office supplies, multimedia resources for teaching, online platforms memberships and items that will be consumed must be specified, planned and provided for a proper semester execution.

7.3.1.5 SP 1.5 Plan Needed Knowledge and Skills

A consistent training program that would help staff members update their knowledge and skills is very necessary to the successful execution of the semester. However, such an initiative requires a lot of external funding, resources and often a lot of time. Further details on Organizational Training will be discussed in Section (7.9). However, it is important to keep in mind that it is a requirement to have training plans, new recruitment plans, know the current skills of you staff members and keep track of their knowledge and skills training at all times. To achieve this specific practice properly, we need to identify where the competence of our staff members stays and how we could further add up on those competences by providing in-house training or outsourced training.

7.3.1.6 SP 1.6 Establish the Semester Plan

Since there are multiple parties involved in conducting the semester plan as well as execution of the semester, therefore, a well documented plan that involves all the parties and targets all relevant planning items is highly required. Such a plan can

bring all the parties involved on the same table and everyone would be following the same picture. This plan would need to put the following points together logically:

- Semester life-cycle considerations
- Semester tasks
- Schedules
- Clear Milestones
- Data management
- Identification of Challenges
- Resource and skills
- Infrastructure considerations

The final work product of this specific practice would be a united overall semester plan that involves everyone in the organization, has considered all aspects of the semester and can be used as a basis for execution of the semester.

7.3.2 SG 2 Obtain Commitment to the Plan

No matter how detailed and accurate a plan might be complied, should there be no commitment from the people in charge of implementing and supporting the plan, then the accuracy of the plan would be of no benefit to anyone. It is highly recommended that the people in charge of running an organization, should make sure to bring up commitment to the plan in those who are running a task. Constant Monitoring, Control, and questioning has proven to be useful methods in making sure everyone takes execution of the plan seriously.

7.3.2.1 SP 2.1 Review Plans that Affect the Semester

Since there are a bunch of process areas running within an organization and the successful execution of all those process areas together contribute to the success of the organization, therefore, it is necessary to review the plans developed by other process areas as well. The plans developed by those process areas has to be studied properly,

people who are in charge, accountable and responsible for tasks within other process areas must be identified. This helps with the planning of the semester and later with the execution. The process areas are related to each other and it is important to consider those relationship at all times. The work product of this specific practice is a record of the review for all those plans from other process areas that would affect the semester planning and execution.

7.3.2.2 SP 2.2 Reconcile Work and Resource Levels

It is important to know your resources and your semester plan. This specific practice requires one to make sure what one has in hand meets the resources. This practice requires editing the plans, justifying the needs for more resources and finding ways to better improve the quality of semester execution. This specific practice can be avoided if planning and estimations are done realistic and the resource pool does not change its status after initiation of the semester. Revised schedules and revised requirements lists are just some example of work products at this practice.

7.3.2.3 SP 2.3 Obtain Plan Commitment

In order to get commitment of all the relevant stakeholders, it is often important to interact with the involved parties. The semester plan should give the right impression that tasks planned can be carried out with the available resources and that there are no ambiguities to the execution of the plan. That way they can feel secure and confident that the task they are assigned to and is something feasible within the time frame and with the available resources. This confidence building automates the commitment procedure and turns commitment into a habit.
Subpractices

1. Identify the needed support and negotiate commitments with relevant stakeholders
   Here a check list is required to figure out all the necessary tasks that require certain commitment. Thus WBS plays an outstanding role in helping out with the compilation of the checklist.

2. Document all organizational commitments

whether it is a complete task or a provisional task, the commitment must be documented and the relevant signatories should be collected. The documentation part helps a mutual understanding for both parties involved and also helps tracking and maintenance of semester execution and progress easier. This also helps the risk management with identifying weak factors in the process.

3. Review internal commitment with senior management as appropriate
   The top down approach can sometimes be used for bringing up the accountability sense in people who are in charge of running tasks within the semester.

7.4 Semester Monitoring & Control

Purpose

The purpose of Semester Monitoring & Control is to keep an eye on the progress of semester activities that were planned earlier. This monitoring mechanism helps with the correction criteria, if something changes through out the semester.

Introductory Notes

A semester plan that has been already devised acts as the basis for the semester monitoring and control process area against which progress of the semester activities are measured. The progress can be measured by comparing the actual work done until that certain point in time with the pre planned milestones or control points in a WBS. Should the actual results deviate from those of the planned values, then a correction step is necessary to be taken in order to meet the semester objectives at the end (Chrissis et al. 2011).

Lack of control and monitoring mechanism in general and a semester specific monitoring mechanism in particular within the IT education institutions were one the few points that some of the survey participants have pointed them out. The participants as well as the author agree on importance of such a mechanism. Random Controlling initiatives are practiced from time to time, but on a regular basis it is often overlooked. Applying, implementing and continually executing such a process area would prepare the organization to acquire the Maturity Level 2.

While working with the semester Monitoring & Control process area the following points are of high importance to be considered (Chrissis et al. 2011):

- Monitoring the whole semester continually
- Control the commitments
- Understand the challenges that might deviate the plan
- Take corrective action when necessary.

7.4.1 SG 1 Monitor the Semester Against the Plan

The main goal is to see how the semester was planned and how the execution has been progressing. The following specific practice is contributing to determining and testing progress of the semester activities that were planned already and to see if every part is running according to the expectations of the plan. The second specific practice of this specific goal deals with taking corrective actions.

7.4.1.1 SP 1.1 Monitor Semester Planning Parameters

The Semester Planning parameters are the main indicators showing the semester progress and performance and they contain attributes of the work products, tasks, effort and schedule. Those attributes are size, complexity, service level, availability and functionality. The repetition rate of these parameters have to be considered, so that the monitoring phase doesn't go longer than the actual semester itself. Record of semester performance and record of significant deviations are particular outcomes of this specific practice.
Subpractices

1. Monitor progress against the schedule
   This part has to be specifically applied on each department member. Their teaching plan has to be continually monitored.
2. Monitor the attributes of work products and tasks
3. Monitor resources provided and used
   PC-Pools, network administration, library and availability of library resources has to be always checked.

4. Monitor the knowledge and skills of staff members
   This part should be specifically taken under serious consideration. For example, the person who is offering a lecture in a specific subject, is s/he competent enough, or does s/he need extra training for better performance.
5. Document significant deviations in semester planning parameters

7.4.1.2 SP 1.2 Monitor Commitments

The specific practice regulates and emphasizes on monitoring of commitment that was already identified in the Semester Plan process area. The outcome would be records of commitment reviews, that would be helpful for both current running semester, to see how the person is committed to the task as well as the future planning stages, when you need to assign tasks to the individual or a group. Reviewing these records, one can decide and have an idea on how the person acts and what is their commitment level.
Subpractices

1. Regularly review commitments
2. Identify commitments that have failed to satisfy the criteria
3. Identify commitments that are in danger of failing to meet the criteria
4. Document the results of the review

7.4.1.3 SP 1.3 Monitor Semester Challenges

The challenges that were already been spotted and found in the Semester Planning process area has to be taken under permanent surveillance. Those challenges could occur again and cause trouble to the semester execution. Some records of semester challenges monitoring could be an outcome for this process area.
Subpractices

1. Considering the current status and situation of the semester, one should review the challenges documentations.

2. Revise the documentation
   As the semester moves forward some new challenges might come up. Therefore, one should always keep an eye on new challenges as they bring new information and require analysis and precautionary measures to be taken for solving them.

3. Always share the challenge status to the stakeholders that are relevant to the semester progress

7.4.1.4 SP 1.4 Monitor Data Management

You planned the data management and thus it requires to monitor what you have already planned. All the activities relevant to the data management should be constantly monitored. It is important to know your planned data management activities are in action and working properly. Review those activities and see they are working according to the plan. The monitoring will allow you to notice issues and their impacts on the data management activities. Never forget to document results of the data management activity reviews, since that is the whole point of monitoring.

7.4.1.5 SP 1.5 Conduct Progress Review

The semester progress is the status of the semester at a given point in time. It is necessary to conduct such progress reviews, specially in the subject's teaching progress. Lack of such periodical reviews often lead to lecture progress being neglected by the staff members who are in charge of running the task. The review can be done formally through written questionnaires or informally. It is important to keep the results of the progress review documented.
Subpractices

1. Communicate the status on assigned activities to relevant stakeholders
   Everyone who is necessary and can provide an impact on the progress of the work is considered a stakeholder and thus as per requirement and necessity should be informed about the progress review.

2. Review the results of collecting and analyzing measure for controlling the semester

This can be directly done through questionnaires filled by students who receive the service and considered a direct beneficiary of the semester.

3. Should there be any deviations, they must be identified
4. Document results of the reviews

7.4.2 SG 2 Manage Corrective Action to Closure

If there is a significant difference between the semester plan and the monitoring results, then it is necessary to take corrective actions and manage them for possible good closure.

7.4.2.1 SP 2.1 Analyze Issues

We need to collect and find all the issues that have affected the progress of the plan and thus take action for correcting them. This step results in a list of issues that require our corrective actions for solving the problems and bringing the progress of the task back to the track.
Subpractices

1. Gather issues for analysis
   All the issues are collected and found through other processes and put together for understanding and analyzing why those issues have come to existence.
2. Find ways for Correcting the issues
   Once you have all the issues and found the reason, then it is time to figure out how to take corrective actions for solving them and avoiding any failure to the process's progress.

7.4.2.2 SP 2.2 Take Corrective Action

The identification and analysis of the issue, requires measures to correct those issues. Thus corrective actions need also proper planning and deep considerations. Corrective Action Plans would be the outcome of this specific practice. It is necessary to determine and document the steps taken for solving those issues and sometimes it

would be necessary to get agreement of the stakeholders for the corrective measures that have been undertaken.

7.4.2.3 SP 2.3 Manage Corrective Actions

Once the issues are identified and possible corrective actions are determined, then it is time to mange those corrective actions and make sure it reaches the closure and ends in the favor of semester improvement.
Subpractices

1. Monitor corrective actions so that they successfully meet the needs
2. The new results must be analyzed to make sure those corrective actions are effective
3. Document the results
   We always learn from our lesson and when those learned lessons are well documented, then they could be used again while planning the future semesters.

7.5 Process Quality Assurance

Purpose
Process Quality Assurance focuses on the quality assurance of processes and hence provide the management and staff members with an insight to the quality of processes.
Introductory Notes
This process area focuses on activities that would make the management and staff members look at the performance of performed processes objectively and compare them against applicable process descriptions, standards and procedures. This process area provides staff members and management with the results of the quality assurance activities. Furthermore the process area makes sure to identify and document issues that does not go well with the standards and provides mechanisms to address those issues.
Currently there is a Quality Assurance initiative running and administered through a central body at the Ministry of Higher Education with the main goal of earning in-

ternational accreditation. The basic work done by this initiative is to let institutions have an internal evaluation of their processes first and later do an external audit by peer universities. In the long run, the universities would be audited by some international quality assurance audit teams and gain an international accreditation certificate. Details of the approach to this initiative is private to the administering body and is hard to gain access to.

The Process Quality Assurance process area provides the management and staff members detailed insight with timely feedback through out the semester. This way producing quality results is guaranteed at the end. It is important to evaluate the quality assurance of processes objectively. This way of thinking and approaching the quality assurance yields to a successful result at the end. Less formal methods are favored for a day-to-day basis of quality evaluation, but formal methods are required for periodical objective evaluation.

Quality assurance activities require trained quality assurance experts. Trainings can be provided* for those who are running the quality assurance activities. It is always recommended to separate the ones implementing quality assurance from those running the product itself. This process area should run periodically and to ensure quality of the services including teaching that are offered to students. This process area is applied to evaluation of semester activities, syllabus management and organizational activities associated to the execution of plans within a faculty.

Selection and inclusion of this process area was mostly due to the fact that a Ministry wide initiative have been already launched, quality assurance is seemingly known to everyone and the survey participants have also pointed out the fact that quality assurance was an important initiative and more work needs to be done in this part. Therefore this process area is assembled considering the CMMI models template and should this process area be implemented and worked through regularly, then it helps the organization reach Maturity Level 2 and as a result pave its way for follow up Maturity levels.

*Refer to Section 7.9 for further insights

7.5.1 SG 1 Objectively Evaluate Processes and Work Products

The processes and work products should be in compliance with the descriptions, standards and procedures available and thus this compliance would need to be evaluated objectively.

7.5.1.1 SP 1.1 Objectively Evaluate Processes

It is the objectivity to the process evaluation that guarantees success of a process or the semester. Some example work products for this specific practice would be evaluation reports that indicate the current situation of the processes. Reports that show the activities which are not in compliance with the original plan and finally corrective actions which indicate how to fix the issue.
Subpractices

1. Make an environment where every staff member contributes to identification and reporting of quality issues
2. Evaluation criteria should be clearly stated
   This sub-practice wants us to clearly define what is to be evaluated, when and how often the process would be evaluated, which mechanisms are used for evaluation and who is involved in the evaluation process. These points needs to be clearly stated, since it would also lead to over work and often loose of interest among staff members for quality assurance.
3. Use the stated criteria for evaluating certain processes that are already performed and compare them against the process descriptions, standards and procedures already in act.
4. Any discrepancy found during the evaluation should be identified.
5. See if there are already existing solutions that could help with the improvement of the process

7.5.1.2 SP 1.2 Objectively Evaluate Work Products

Pick up certain work products and evaluate them objectively against the relevant process description, standards and procedures. Did the work product follow the same standards during the creation? Does it have a good quality? The outcome of this specific practice is nearly the same as the previous specific practice (Objectively Evaluate Processes). However, this specific practice focuses on selected work products only.

Subpractices

1. Select your work product for inspection based on certain methods
   If you use sampling as a method for selection of the work product, then it should be documented properly. A work product can be a service, a lecture offered to students or a file handling system in the Students Office. It is important to know what you are evaluating and against what criteria.

2. Evaluation criteria should be clearly stated
   This sub-practice wants us to clearly define what is to be evaluated, when and how often the process would be evaluated, which mechanisms are used for evaluation and who is involved in the evaluation process. These points needs to be clearly stated, since it would also lead to over work and often loss of interest among staff members for quality assurance.

3. Use the stated criteria for evaluating the work products.

4. Specify the time for evaluation of the work product.

5. Any discrepancy found during the evaluation should be identified.

6. See if there are already existing solutions that could help with the improvement of the process.

7.5.2 SG 2 Provide Objective Insight

We need to track down and communicate issues that are not in agreement with quality and make sure there is a resolution for those issues. This specific goal refers mostly

to the low quality issues that are found a long the way and puts emphasize on discussing the low or bad quality of the product with the section in charge and find ways to improve those issues.

7.5.2.1 SP 2.1 Communicate and Resolve Noncompliance Issues

Once the problem and bad quality issues are found, it is important to discuss those issues and make sure to provide a resolution to the problem and improve the quality together with the staff and the manager. The results of this specific practice would be corrective action reports indicating measures for solving the issues, evaluation reports indicating the status and quality of the product being inspected as well as quality trends showing means of improvement of the quality.
Subpractices

1. Any noncompliance issue should be resolved with the relevant staff members
2. Should you find a non solvable noncompliance issue, document it for future semester planning
3. The noncompliance non solvable issues has to be brought to the management levels that have the authority and means to solve the issue.
4. Analyze noncompliance issue to find possible quality trends that may require additional attention
5. Make sure all the relevant stakeholders know about the analysis results
6. Track noncompliance issues to reach a possible solution

7.5.2.2 SP 2.2 Establish Records

All the quality assurance activities that are run through out the educational institution should be recorded and those records must be maintained. Quality assurance is a long process and needs patience until optimal quality is reached. The longer the records are kept and maintained the more lessons learned scenarios would appear that could help solve issues accordingly. The outcome of this specific practice would be evaluation logs (be it questionnaires or structured interviews), quality assurance reports, status reports of corrective actions as well as reports of quality trends.

Subpractices

1. Record details of process and product quality
   It is important to record all possible details about process and product quality assurance activities, to show the depth of the evaluation and to help with finding resolutions for the noncompliance issues.

2. All quality assurance activities related status and history should be revised as per the need of the quality assurance team

7.6 Requirements Development

Purpose
The purpose of this process area is to give the requirements selection and requirements acquiring process a systematic approach.
Introductory Notes
Every semester has its common requirements as well as special requirements. The common requirements can be managed generally and can be used again and again. However, the special requirements that are needed for development of a specific task need to be addressed ahead of time and need to be well planned. In government institutions like in Afghanistan, having no financial freedom, makes it more difficult to acquire certain factors for development or provision of a service or product. This process area focuses on those requirements and requires the people in charge to think well ahead of time for figuring out how to gain access to those requirements. Here the needs of all relevant stakeholders have to be considered and they can be identified and refined through out the educational life cycle.
For this we need to run an analysis at each phase of the study program to understand our needs, find the requirements for further development and select the ones needed at most. The needs of the stakeholders, the environment in which the educational process runs, the factors that would reflect the stakeholders satisfaction and expectations should be considered for analysis. Furthermore, we need to develop an operational concept showing a way on how to reach those goals and acquire the requirements and show how those requirements could contribute to the quality of our service/product.

Activities that carried out through out the semester as well as through out the whole educational period have their requirement and they need to be developed in a systematic way to keep the entity functioning properly at a long run. That is why this specific process area deals with preparing the organization develop its requirements and continually improving them. As a result of the successful implementation of process improvement initiatives in this regards, the organization could reach up and until Maturity Level 3. We should keep in mind that to reach Maturity Level 3, the earlier maturity levels should be achieved. This Process area depends on the maturity and capability levels of the previous process areas and can contribute to; organizing and implementing them as well.

7.6.1 SG 1 Develop Customer Requirements

All the needs, expectations, constraints and possible satisfaction factors of the Stakeholders are collected and turned into customer requirements. These factors are the basis for knowing what our stakeholders (students, teachers, administrative employees and management) need and they would be analyzed and refined into a set of customer requirements. It is common that those factors are poorly explained by the stakeholder and thus sometimes they even don't know what they want. A good practice to avoid any possible misunderstanding is to keep an open communication channel with all the stakeholders and have their opinion in defining and refining the requirements.

7.6.1.1 SP 1.1 Elicit Needs

Elicitation is more than just collecting requirements that are not explicitly provided by the customer. They are detailed extra information one needs to find and collect to build a clear picture of the requirement in hand. With the help of several methods and technological solutions this specific practice wants us to look beyond the needs of the stakeholder. The end product of this specific practice would be a detailed requirement elicitation documentation that gives a big, detailed and clear picture of what the customer wants.

Subpractices

1. Talk directly to the stakeholders and provide them with extra information to clear out the idea for them and draw a picture of how detailed the work product would be at the end

7.6.1.2 SP 1.2 Transform Stakeholder Needs into Customer Requirements

All the needs, expectations, constraints and possible satisfaction factors of the stakeholders are turned into prioritized customer requirements. All the gathered information so far has to be put together, analyzed properly and if there were any miscommunication of information as a result of which a requirement was not understood properly, they should be resolved and completed. This is when we can build a complete Customer requirements base. When all these put together one can build a priority based customer requirement.
Subpractices

1. The needs, expectations, constraints and possible satisfaction factors of the stakeholders should be properly documented as a customer requirement

2. We should put a priority to the customer's functional and quality attribute requirements
   Putting priority helps focusing on which requirement to be achieved and implemented during the execution phase. Knowing which requirements contribute to the functionality of the studies and which ones would improve the quality, will allow the institution to focus their Quality Assurance Process area as well.

3. The constraints have to be identified again

7.6.2 SG 2 Develop Product Requirements

This specific goal concentrates on refinement of the customer requirements from the previous specific goal and turns them into product and product component requirements. Here the main idea is to form a base for development of the product which is needed. The product could be a service, a lecture or a subject offered at the faculty. Therefore, elaborating the needs of the customer and understanding the

existing constraints, we are trying to develop a product that is required by our customer. Requirements management process areas can also help with compilation and execution of this specific goal.

7.6.2.1 SP 2.1 Establish Product Requirements

This specific practice needs the customer requirements to build and maintain the product requirements. Points the customer and provides information related to the functionality. Quality of their expected product are described in nontechnical terms and in order to turn those informal information into a functionally and academically accepted terms we need to translate them here. The product requirements concentrates on satisfaction of the customer, the business and the project objectives, here in our case, the students and lecturers, the educational institution and semester subject and plan.
Subpractices

1. The requirements should be turned into technical terms for products development

2. Requirements can be taken from design decisions
   This particular sub-practice should be closely watched, as decisions for what and how to provide a service to the students depend on external resources, which then again have their own requirements. Such issues should be considered while establishing and confirming the product requirements. These external issues would cause more work and change the requirements as seen at this point.

3. The relationship between requirements should be clarified
   This relationship helps with requirements management process area as well as with the evaluation of change impact in the requirements.

7.6.2.2 SP 2.2 Identify Interface Requirements

The products are interrelated and it's important to identify the interface between those products, their interrelationships and their impact on the customer requirements. The interface between the subjects is defined within the study program and

it should be clearly stated how they complement each other or impact one another's performance should they be neglected.

Subpractices

1. The external and internal interfaces should be identified
   In the example of a study program, the internal interfaces would be a subject's link to the next subject and the external interface would be the students ability to interact with a real life problem and trying to solve the problem.

2. Develop the requirements for the identified solutions
   The requirements for interfaces are again a list of extra information that helps with understanding of the product relation to its environment and its impact on the environment.

7.7 Organizational Process Definition

Purpose

Organizational process assets, working environment standards, rules and guidelines for the staff members should be established and confirmed.

Introductory Notes

This process area is concerned with collection of all the organizational processes that define the organization's execution status and manner. Improvement to this part would bring about the overall organizational improvement and success in the long term. It is advised to build an organizational process assets library to support the organizational learning as well as organizational process improvement. Such a library would allow staff members have access to all the guidelines and regulations and can contribute to better performance of the organization when they are required to carry out a task. This library would have details of processes that are developed over time with experience and lessons learned from the mistakes of the past.

The survey participants often pointed that they were not informed of the organization guidelines and had often difficulty getting access to those guideline when they needed them. That is why this process area is selected and integrated in this work to facilitate and help building such a mechanism where everyone in the organization could have easy access and could learn them accordingly.

The standard set of processes in an organization forms the way the organization interacts with all its beneficiaries and stakeholders. Those standard processes regulate the way the semester activities are planned, managed and executed. The rules and guidelines allow staff members to know their rights and limitations for pursuing certain tasks while executing a process.

Standard set of processes are already defined, guidelines and regulations exists and it is mandatory for each member to learn them and understand them in my case, IT education institutions in Afghanistan. However, what is often neglected is the lack of control mechanism and it happens often to see a staff member making mistakes because s/he didn't know the regulations related to a work situation. On the other hand Computer Science faculty is a new field of study and still in its developing phases that has been established in state-run universities around the country, therefore, this process area is included to highlight the importance of existing guidelines as well as rules and best practices. If the faculty is planning on expansion and bringing in new study majors, then is the time when the importance of this process area could be glittering. For the improvement of current existing processes, the Organizational Process Focus process areas is suggested to be used.

7.7.1 SG 1 Establish Organizational Process Assets

The specific goal requires us to build up process assets and maintain them. This way all the policies, guidelines, standards and regulations that are needed to run an organization is formed and put into action. At the same time a good resource for unknown situation as well as newly joining members would be created and upon demand could be accessed. Each of the following specific practices are concentrating on one of the aspects.

7.7.1.1 SP 1.1 Establish Standard Processes

Every organization needs a set of standard processes to regulate the activities and to form the way works are done. These regulations can be common for all sections, departments or branches of the organization or could be related to a specific section. For example the recruitment of a new staff member belongs to the HR Department of the University, so all the related regulations and guidelines for appointing a new

member is set and defined. The new faculty member will be appointed at the Department unit in accordance to the standard guidelines defined by the HR Department.

These standard processes can be mapped to each business areas or standard services. The standard set of processes can be applicable for the whole organization or just a specific part of it.

Subpractices

1. Each standard process has to be broken down into details
   There are a set of related activities that comes within a process element. All these small activities that comprise a process should be explained in such details that when the process is put into execution, the people in charge of the execution are left with no questions and can manage the process. Details of definition is the key to the successful implementation of the process by the related skilled people.

2. Critical attributes of each process element has to be specified
   Process roles, standards that could be applied, procedures, tools and resources that are needed to run the process, the objective of process performance and end results could be some examples of the critical attributes one would want to look for in a process.

3. The relationship among process elements have to be specified
   The important requirements and guidelines of the process elements has to be clearly set and defined so the relationship is clear. The process elements should be clearly noted with which other processes they are interacting and what are their dependencies.

4. Ensure that the organization's set of standard policies follows applicable models, policies and standards.
   Later on this helps with the appraisal attempts of the organization. This way you would make sure the process elements you have defined are adherent to the standard processes and policies of the organization and you would have also prepared your process elements for a next step appraisal initiative.

5. The organization's set of standard processes should satisfy process needs and organizational objectives
   The set of processes should be defined in a way that solves the process execution issues of the organization and helps the organization achieve its goals.
6. The organization's set of standard processes should be documented
7. The organization's set of standard processes should be reviewed
   It should be possible to review those standard processes periodically and should there be better ways to run the tasks, they should be integrated with the standard processes' definition. Always new ways of running the processes come up that could save a lot of time and other costs. The revision could allow the organization benefit from those new ways and improve the processes. This is something really necessary to be allowed in the higher education system of Afghanistan in general.

7.7.1.2 SP 1.2 Establish Organization's Process Asset Library

This is basically a library of organizational assets such as policies, descriptions of processes, plans, training material and semester activity reports.
Subpractices

1. Design and define a structure for the library
2. Choose items that are necessary to be included in the library
   The items which are mostly related to the standard set of organizational processes are selected for keeping at the library.
3. The procedure for storing, retrieving and updating of library items should be defined
4. Enter the items in the library
   Keep an easy structure for storage and retrieval of the library, since everyone involved in the organization will need to access the library often. All staff members should be able to use the library during the execution of processes, being compilation of a semester plan or lecturing a class.
5. Keep reviewing the items periodically and keep your library updated

7.7.1.3 SP 1.3 Establish Work Environment Standards

The work environment is a common ground for all staff members, their activities and the rest of the stakeholders. The work environment standards focus on the workplace, security, safety and other environmental issues of all the stakeholders. These standards can be guidelines and policies for using the work environment resources fairly and safely. The idea is to provide all stakeholders with a healthy work space to run their activities in ease of mind and in the best possible manner.

Subpractices

1. The work environment standards commercially available should be considered for applying into the work environment
2. The existing work environment standards should be adopted and new standards are to be developed when there is a gap

7.7.1.4 SP 1.4 Establish Rules and Guidelines for Teams

All teams that are needed to be created for running a task within a faculty has to have clear guidelines for their creation, their structure and operation. These guidelines would define and control the way teams are working and supposed to work. Every member of the team is required to understand those laws, regulations and guidelines to be able to achieve the organizational and team objectives without any troubles. These guidelines should be created in accordance to the organizational and local laws to give the team freedom of activity. These teams would need a clear structure showing each member's position, responsibility and role within the team and how the team interacts with other teams and within the whole organization. The working committees defined in the faculty are a good example for this specific practice.

Subpractices

1. Based on a clear mechanism the team members should be given freedom of decision to react to situations on time
   This would provide team members the ability to interact with new situations under the lights and empowerment they receive from the guidelines and regu-

lations. Their authority and responsibility would be clear in the guidelines and using a good documentation process, they could react to the situation. This is a challenge often seen in the working environment of the study. Even though guidelines are there, but to make sure you are allowed to do a task, you need to gain authorization from the chain of management, which is quite costly in terms of time and often yields to disinterest and discontinuation of the task by team members.

2. Rules and guidelines for structuring teams should be established and maintained

3. Rules, guidelines and expectations should be clearly defined
   They need to be clearly defined so the teams can understand how to work collaboratively and support each other's work if necessary.

7.8 Organizational Process Focus

Purpose
The idea for this process area is to take the process improvement initiative, knowing and understanding details of the current organizational processes and process assets including all their weaknesses and strengths.
Introductory Notes
Every process that runs within an organization and keeps the organization's activities moving forward is called the organizational process. An organizational process is selected for improvement based on its current execution status, lessons learned after execution, the process appraisal results, results of service or product evaluation by the customer or the stakeholders and finding a process is slow and its alternative for improvement, are all parts of selection criteria why we need to improve a process. A process improvement takes place within the organization and thus a best practice would be to involve people in charge of the process as well as providing adequate support, means and organizational commitment for the improvement to take place. Such an initiative requires proper and careful planning and the resulting plan is documented within an organization's process improvement plan which addresses appraisal planning, process action planning, pilot planning and deployment planning

for the new and improved process. The objective of this process area is to find the process improvement opportunities within your organization, plan for the implementation of the process improvement initiative and finally apply your plan and deploy the new and improved process.

7.8.1 SG 1 Determine Process Improvement Opportunities

Know your processes, their strengths and weaknesses and find the improvement opportunities within them. This specific goal focuses on finding the processes that need improvement because they are slow or old fashioned. This step needs to be done in relation to a specific standard model, either a CMMI or an ISO. The choice stays with the organization's policy for process improvement. This improvement should address the organizations needs and should lead to a better and improved process not a more complicated process. Several reasons such as a change in the business or legal and regulatory requirements could bring up the process improvement opportunities as well as the need.

7.8.1.1 SP 1.1 Establish Organizational Process Needs

The process needs description and objectives of the organization should match each other. The processes should be understood in its business context. The organization's business objectives, needs and constraint draw the line for the needs and objectives of the organization's processes. Some of the important process considerations could be students satisfaction, technology, quality and human resources.
Subpractices

1. Find the policies, business objectives and standards that can be applied to the organization's processes.
   This could be ACM syllabus and curriculum, the ISO standards that deal with quality of teaching and services within an educational institution.
2. Find the best practices relevant to those standards
3. Determine the organization's process performance objective

It is expressed in either quantitative or qualitative approach. It can be measured against the time the process needs, the goal it holds to reach or in terms of quality .

4. Define essential characteristics of the organization's processes
   The processes that are currently being used, what is their characteristics. What standards are being imposed by the organization and what standards are expected by the students? Why did organization choose this specific standard or approach to delivering the process results?
5. Document the needs and objectives
6. Revise the needs of the organization processes as needed

7.8.1.2 SP 1.2 Appraise the Organization's Processes

In order to know the weaknesses and strengths of the processes it is needed to do a periodical appraisal to keep an eye on the changes between the weaknesses and strengths at all times. This specific practice would result in development of appraisal plans, findings of the appraisal on weaknesses and strengths as well as a recommendation on improvement of certain processes in the organization.
Subpractices

1. Senior management should provide you with appraisal sponsorship
   You need to gain the senior managements sponsorship and support so that managers and staff members would participate and cooperate with you in running the appraisal. Furthermore you would need financial support for running the appraisal and analyzing the findings and thus it is important to have senior management's support.
2. Process appraisal scope has to be specified
   It is always recommended to be specific about the range of appraisal you are planning to conduct. This appraisal can be carried out on the entire organization, an entire process area or just a small part of a process area. The choice entirely depends on the appraisal goals and support you can earn from the senior management.

3. Choose your process appraisal method
   The appraisal could take place in different forms. It could be based on a national or international accepted model or based on known similar organization's achievements in process improvement, given that the results are available to you. The time you need for the appraisal as well as the findings depends on the depth of the appraisal plan, the number of appraisal team members, and the commitment of staff members who would be willing to cooperate with you.
4. Run the process appraisal
5. The appraisal activities and findings has to be documented and delivered to the relevant stakeholders

7.8.1.3 SP 1.3 Identify the Organization's Process Improvement

Choose the organization processes that needs improvement and what can be improved within those processes. This specific practice deals with selection of the process that needs to be improved and an analysis of what needs to be improved within that process.

Subpractices

1. Select processes for improvement
   This can be done through analysis, review and measurements of process results.
2. Give priority to the selected processes for improvement
   It is important to start the process improvement with those processes that are of higher relevance to your organizational objectives. The criteria for setting such a priority could be set after costs, efforts, expected improvements in the process, running time, or possible barriers that would slow down the process improvement initiative.
3. The process improvements that need to be applied has to be identified and documented properly
4. Revise the list of planned process improvements for having an updated list

7.8.2 SG 2 Plan and Implement Process Actions

The actions required to address the improvement of organization processes and processes assets are needed to be planned and then implemented. If you want to implement your improvement actions successfully, it is highly advised to include those who are actually running the process to be part of the improvement plan as well as the implementation. This way you would have first hand experience from experts at running the processes.

7.8.2.1 SP 2.1 Establish Process Action Plans

This specific practice focuses on building and maintenance of a process action plan that would be used to take care of the organizational processes and process assets improvement initiative. Such an action plan is required to indicate what is to be done at which part and on which organizational process or process asset. At this stage it is advised to involve stakeholders as they would help with the planning process and later could be of great help in deployment of the plan. Such action plans are in fact detailed implementation plans that specify every step of the job clearly.
Subpractices

1. The actions and approaches for identified process improvement is defined
   The strategies and approaches on how to implement the improvement on the selected processes is clearly stated. Any new and unproved improvement would be put into testing and piloting phase before actually incorporation of the new improvement in the real day to day job situation.

2. Application of changes require teams
   It is necessary to have teams for applying the improvements. The team members could be specific people assigned to the improvement task as well as the people who are actually working with the process.

3. Document the process action plans

4. The action plans need to be shared and reviewed with the relevant stakeholders

5. The action plans if needed has to be regularly revised

7.8.2.2 SP 2.2 Implement Process Action Plans

The action plans that are already established and ready needs to be implemented. The following sub-practices are hints on points to be considered during the implementation part. You would need to constitute commitment among process action teams, keep a progress report on the status and results of the process action plans and should there be new unproven changes to the process, they need to be planned for a pilot or trial deployment as well.

Subpractices

1. Stakeholders need to have access to the process action plans
2. Track the progress and commitment against the process action plans
3. Hold joint meetings with stakeholders and implementation team to review the status of the action plan
4. Plan pilots needed to test selected process improvements
5. Review the activities and results of the action teams
6. Document, track and identify the issues during implementation of the process action plans
7. Make sure the results of the new improvements meet the organizational process improvement objectives

7.8.3 SG 3 Deploy Organizational Process Assets and Incorporate Experiences

This specific goal focuses on deployment of organizational process assets within the whole organization. Here the current activities are described. It is necessary to always look for improvement of processes since there will be always new opportunities that would show up during the execution of processes.

7.8.3.1 SP 3.1 Deploy Organizational Process Assets

Organizational process assets should be deployed across the whole organization in an orderly manner as the organizational process assets and changes to them might

not be executable in parts of the organization. It is important to consider involvement of others who are running similar process areas such as quality assurance or training during the deployment of the process assets.

Subpractices

1. Deploy the organizational process assets across the organization
2. Document changes
   The changes need to be documented so the changes can be explained and also to learn and understand the relationship between the changes.
3. The changes that were made to the organizational process assets has to be deployed across the whole organization
4. Provide guidance and consultation on the use of organizational process assets

7.8.3.2 SP 3.2 Deploy Standard Processes

The standard set of organization processes are to be deployed at the beginning of the semester and the changes to those standard processes should be deployed in the right point in time through out the semester. Acquiring critical activities such as planning, receiving requirements and resources should be always done at the very early stages of the semester planning and execution. The defined processes of the semester should be always updated. Guidelines for deploying changes and organization's standard processes should be provided.

Subpractices

1. Identify the projects that are starting up in the organization
2. Notice the current running projects and whether they would benefit from those standard processes
3. Build plans for implementing the current set of standard processes on the projects
4. After organization's set of standard processes are updated, select the projects that are going to apply the new changes

7.8.3.3 SP 3.3 Monitor the Implementation

Monitoring the implementation of the organization's set of standard processes and process assets allows the organization to make sure that they are deployed correctly on all projects. This specific practice is to insure that the deployment has taken place and the improvements are understood and those running the processes are trained and can work with the new improvements without any problems. As a result of monitoring the organization finds out whether everyone knows where the improvements are made and how they are used or not.

Subpractices

1. Monitor the use of process assets and their changes on the project
2. Review selected processes results
   This is to ensure that everyone in the organization is using the incorporated changes and the improved process correctly.
3. Review the audit reports to see how well the changes are incorporated
4. Find and document the problems related to the new improvements
   This is important to figure out which problems did the new changes cause to the organization process assets.

7.9 Organizational Training

Purpose

The idea behind this process area is to focus on capacity building, skills and knowledge improvement of people so they can perform their tasks efficiently and effectively (CMMI 2010b).

Introductory Notes

Training of current staff members are one of the keys to successful, efficient and effective implementation of processes, tasks and projects within the organization. The more skilled the staff members the better the tasks are executed saving both quality and time as well as related catastrophic costs. The customers are more satisfied. Training in Computer Science faculties of Afghanistan as an educational institution offering higher education is very essential. Due to lack of resources, candidates with

a bachelor degree are hired as a lecturer to teach a Bachelor Degree Study Program. Now those lecturers with bachelor degrees require master degree studies and education. They need to travel outside the country for obtaining the qualification in a master level. An organization that offers a Bachelor Degree Study program and plans to offer a Master Degree Study program need to extend its staff members qualification to further PhD degrees. That is why Organizational Training has to be closely watched and considered during the Semester Planning. Organization Training does not stop at the qualification study programme. The newly recruited lecturers need to gain training in various administration as well teacher training programs. The survey participants have emphasized on lack and missing the opportunity of getting an approporiate on the job training, before or at the beginning of their teaching careers.

This process area focuses on provision, importance and assessing mechanisms for trainings within the organization. The staff members should receive their training whether on site or their training programs should be outsourced, depending on the availability of resources. This process area helps in identification and planning of the organizational training. The results of this process area would be finding the necessary training, providing the training, establishing training capability within the organization and eventually assess how effective the trainings are.

It is important to consider the technical, organizational or contextual aspects of a training program when we want to improve skills and knowledge of the employees. Technical skills would enable and update skills of staff members to work with technical issues, processes, data and it could also include academic degree trainings. Organizational skill would focus on improvement of employees skills in handling organizational processes. The contextual skills are focusing on personal, communication and self management skills of the employees which is a necessity for everyone attending a class room teaching scenario. The following specific practices and their sub-practices helps us with notifying actions necessary to be taken for organizational training process area. The systematic and continual implementation of this Process Area prepares the organization for acquiring Maturity Level 3 (CMMI 2010b).

7.9.1 SG 1 Establish an Organizational Training Capability

This specific goal encourages organizations to identify the trainings that are required for development of skills and knowledge of staff members which would result in their performance improvement. Here the needs of the organization has to be identified so that proper training programs are developed. Staff members of the faculty have bachelor and master degree qualifications. Those with bachelor degrees need to be provided with training opportunities to gain a master degree and those with a master degree should pursue a PhD program. Next to this major academic degrees, they need certain trainings in personal and self management skills, teacher training methodologies, networking and hardware trouble shooting skills as well.

7.9.1.1 SP 1.1 Establish Strategic Training Needs

Strategic training needs are identified and plans are made for establishment of those trainings. These strategic plans are long term objectives to build a certain capability. In our example Master and PhD training programs for the staff members would fit in the strategic plans. The training needs and the assessment analysis for realization of these plans are the end results of this specific practice.
Subpractices

1. Analyze the strategic business objectives of the organization
   This analysis helps understand the long term objectives of the organization and process improvement plan. The process improvement plans could bring up new processes together with new business objectives that would require more or certain and specific qualifications within the people who are supposed to run them.
2. The strategic training needs should be documented
3. Determine the roles to perform the standard processes.
4. Document the training needed to perform roles
5. It should be documented that the business operation don't stop during the training

6. Keep revising the strategic needs and the required trainings at all times

7.9.1.2 SP 1.2 Determine Which Training Needs Are the Responsibility of the Organization

Trainings should be categorized into trainings needed to be provided by the organization and trainings that are required to be taken care of by the individual or group within their small working circle. The organization focuses mostly on strategic trainings whereas short term and personal skilled related trainings should undergo within the working group or by the individual on their own. The border line between the two, needs to be specifically outlined.

Subpractices

1. The short term trainings should be identified
   Training needs by the working groups have to be identified and analyzed. This analysis can help with the identification of trainings that would be required through out the organization but at the working group levels.

2. Discuss the ways of providing trainings with the working groups
   This support directly correlates with the available training resources and training staff and how the organization prioritizes those trainings.

7.9.1.3 SP 1.3 Establish an Organizational Training Tactical Plan

This is the plan that indicates how the organization will deliver the training to the staff members and the working groups and individuals so they can perform their roles effectively. This plan conveys means of execution of training in near time so the individuals and working groups can see the execution time. However, the plan may vary depending on the changes in time or resources.

Subpractices

1. Make contents of the plan
   This includes training needs, contents, topics, schedules, duration, requirement and other possible related explanation that clarifies the near time execution of the plan.

2. Commitment to the plan
   The people who are supporting the execution of the plan and the one who are benefiting from the execution should fully commit in deploying the plan. The one's receiving the trainings might work less hours and others who stay in the office might have to over work, that is why it is necessary to document all those commitments.

3. Keep the plan and the commitments revised

7.9.1.4 SP 1.4 Establish a Training Capability

A training capability should be established so it can meet the training needs of the organization. Training material and other related facts and figures that would help others take the trainings in the future should be collected and maintained. The ability of offering trainings on the job should be established.
Subpractices

1. Choose wise methods to meet the organizational training needs
   There is a huge range of problems associated with selection of training program that needs to be established within the organization. The difference of knowledge and skills, the over work of some employees, the costs and the work environment are some aspects that need special attention. The selection process should consider an approach that would be most effective in realization of the given constraints.

2. Decide if you develop the training material internally or acquire them externally
   You need to determine the costs, competence and benefits of internal training and the external training acquisition.

3. Develop or obtain training material
   The organization itself, the Department, the working group, or an external organization can provide you with the training. The people in charge of organizing those trainings decide how to deliver and acquire the training without consideration of the source.

4. Develop or obtain qualified instructors and mentors
   You can asses the qualification and ability of those providing training internally. This measure enables you to focus on the ability, skills and knowledge of the trainers by looking at their background, experience and work qualifications. If you hire an external organization to provide the training, you can look at the organization's process of hiring trainers for their organization's competence and base your decision on the way they hire trainers for the job.
5. Revise the training material and other supporting means

7.9.2 SG 2 Provide Training

The individuals who need to perform their roles more effectively receive their trainings. You need to pick up the training group based on certain criteria. Do they have the required prerequisite to receive this training? What is their current ability to perform their roles? Does the person in question need an organizational training or a functional training only? These aspects can be used as the basis for selection of the person to attend a training.

7.9.2.1 SP 2.1 Deliver Training

Considering the organizational training tactical plan while delivering the training. This constitutes the training action and the required course based on the type of training already planned and confirmed in the tactical plan.
Subpractices

1. The individuals to receive the training are selected
   The idea of the training is to improve performance of individuals in the specific role they are working at with the main idea to improve those performance criteria.
2. Make the training schedule indicating all the resources
   All the resources including the facilities and instructors have to be included in a clear schedule. Sometimes a training on the job is preferred by the organization and thus it is necessary to allocate training time for the people receiving the training within their job and working hours.

3. Deliver the training
4. Follow the delivery according to the plan

7.9.2.2 SP 2.2 Establish training Records

Since training can be a continuing activity within the organization and more people may need receiving certain trainings, therefore, it is important to have a record of the training for future references. However, this is applicable only to the trainings applied on the organizational level. Work group trainings can be recorded within the work-group, but may not be useful to other organizational units.
Subpractices

1. Keep record of all training participants who successfully complete each training course or fail to succeed
2. Keep record of all staff who didn't receive any trainings
   This includes those who could not participate due to time constraints and other work related issues and those who are skilled enough and don't need to receive the training again.
3. Provide the training records to the management for job assignment considerations
   This way when the management thinks about starting a new task or project, would have access to an update repository that indicates every member's skills, knowledge and experience.

7.9.2.3 SP 2.3 Asses Training Effectiveness

The organization's training program should be assessed regularly to find the effectiveness of all the training programs that its staff members have gone through. This Specific Practice (SP) would find out whether the trainings were effective and can be followed more or they didn't do any changes and the organization need to stop them and find other alternatives. This assessment can be done through effectiveness surveys, training program's performance assessments, instructor evaluation form and training examination and results.

Subpractices

1. Asses the training effectiveness during or at the end to find out about sufficiency of knowledge and skills of staff members
2. Apply a mechanism for a regular assessment of the trainings effectiveness
3. Listen to the participants self evaluation how well the training program has affected them

8 Conclusion

Chapter 8 summarizes the study at hand, explains the benefits and challenges of the analysis and presents an outlook to the future of IT Education in Afghanistan. The study at hand is a proposal to draw the attention of leaders, decision makers, managers and those responsible in an organization towards the implementation of new and modern management approaches. The new approach presented here wants all stakeholders involved to think of improving the processes within the organization.

Chapter 1 is an introduction to the whole work, presented the motivation for the study at hand as well as the structure and scientific approach to this dissertation. The research question is presented in this chapter and based on the research question a hypothesis is formulated. Further more a clear road map of the study as well as the structure of the work at hand is explained.

Chapter 2 serves as an introduction to the country, the education history and the education system of Afghanistan. This chapter serves as a basis to provide those readers with an introduction to the administration system in Afghanistan. However, in order to keep the topic on track, everything that leads to the administration structure and system of the organization within which the study has taken place has been in-

cluded in this chapter. In this chapter readers will get an idea about how the education system has worked and evolved in the country.

The chapter tackles the development of the Afghan education system from traditional home and mosque education to today's so called modern education where one gets a chance to study Informatics at different universities around the country. The mosque education still runs in the country and in most of the villages and rural areas children get their first touch with education there. The chapter serves the purpose of providing readers insight on how the education system is split between two ministries - Ministry of Education and Ministry of Higher Education -, how the students enrollment to higher education is administered as well as what the current strategic plans concerning IT education is.

A short history of the evolution of the education system was included to present how much different reigns and governments contributed to the improvement of education in Afghanistan. Writing a short summary from each reign here serves as a reminder that the current education system, whose administrative tasks has been separated between two Education and Higher Education ministries, is the result of long years of exercising different approaches to reach a stable system. Appreciating the past efforts, this work introduces a new approach that could be used to bring further improvement to the system and provide the government with a systematic and easy to adapt solution, i.e. a mini CMMI Framework.

Chapter 3 discusses various models and tools that tackle the needs and ways to measure and improve quality. Hence making sure that CMMI is not the only model that deals with process improvement and quality improvement. Some of the reasons this model was picked as the basis for this work are its availability in the public domain, detailed explanation on steps to be taken towards the process improvement initiative, its adaptability to organizations with different natures, its openness to interpretation and freedom of implementation choices to focus on one specific process that leads to capability improvement (Continuous Approach) or a whole group of process areas that lead to organizational maturity (Staged Approach). This enables the organizations to decide whether they want to improve certain processes independent of each other, or provide enough resources, funds and commitment to improve numerous processes at the same time. This freedom of choice of implementation

under the same ceiling was one of the major reasons, this model was chosen to work with in the first place. Government educational institutions in Afghanistan have no financial freedom; thus, investment in proprietary models is almost close to a no go. Therefore, a tool is needed that gives the possibility to show decision makers in the government to see process improvement opportunities in small scales without making a large investment.

Since the findings of the survey proposed the need for process improvement, CMMI is the main tool that is used as a standard process improvement model. As CMMI plays the main part of the hypothesis, a short introduction is provided in chapter 3. It can be used by managers and leaders at different management levels by students and other computer scientist fellows. *

CMMI for Development frame work has suggested 22 process areas to be worked on; sixteen of them being the core process areas for the whole CMMI framework, five process areas being specific to development (software) and one process area being shared across all the three CMMI models. Even though, the CMMI for development targets organizations with a software development nature, it is still possible to adapt and customize this model to any other business environment.

In Chapter 4 methodology and the data collection approach are explained. As the study at hand focuses on qualitative methods, the data was collected using semi-structured questionnaires with two types of pre-coded and open questions. This work is based on qualitative research approaches and similar to the CMMI's early stages that focuses on qualitative improvement, the study at hand follows the same opportunity.

The chapter explains the setup of the research and introduces the Faculty of Computer Science at Herat University. This faculty was selected as a base for the work, but since all public universities around the country follow the same structures and mechanisms, opinion of colleagues and IT experts from other universities were also gathered. This gives the author the opportunity to build a solid picture of the current status of IT education institutions around the country and bring the points that need further improvement together.

*For accessing the material on the original model please refer to the SEI Digital resources at the following URL: https://insights.sei.cmu.edu/library/cmmi-for-development-version-13/ [Last Accessed on 12.Oct.2024 02:06]

Chapter 5 presents the data analysis that were collected through the questionnaires. The different sections of the questionnaire are grouped together and similar questions are put into categories and the qualitative answers are analyzed and presented to the readers. The answer to some of the semi-structured questions yields to presentation of graphs depicting the answers and helping the analysis.

The literature review and the analysis of the data collected has shown the potentials, varieties and openness of CMMI, thus, opens an opportunity for implementation, customization and adaptation of CMMI in an IT Education institution. Hence, this dissertation tackles the topic of the need to process enhancement in IT Education institutions in Afghanistan and therefore, proposes a theoretical model to be used for this goal.

CMMI being originally built for Software Development environments has passed more than 20 years of its life cycle; with the most recent updated official release of version 2.0 in 2018. Due to its openness numerous scientists adapted this model into different (business) areas with the goal of process improvement. These cases include, among these, financial systems, the automotive industry, information technology security, aviation as well as education systems.

In Chapter 6, nine process areas of the CMMI Development model have been chosen and justified. Furthermore, the sub practices are explained that are compatible to the nature of organization in study, and when required, examples related to the actual situation of the organization have been given. This translation and customization was needed to provide easy grounds for implementation of a pilot project in the Computer Science Faculty.

This would help people implementing the process improvement initiative to focus only on getting the job done. For example, in Semester Planning process area which was often highlighted as an important task by the survey participants as well and presented in the following chapter — is an equivalent of the Project Planning process area in the main CMMI for Development model. Here in this particular example the financial estimation efforts for the project has been omitted, since computer science faculties at Afghan universities do not have financial autonomy and freedom to plan and estimate budget needed for their resources. All the financial requirements such as salary of the staff members and procurement needs of the faculty

are processed based on a static financial procedure through the office of the Deputy Chancellor in Administrative and Financial Affairs which is then forwarded to the relevant Financial and Administrative offices at Herat Province and subsequently at the Ministry of Higher Education as well as Ministry of Finance. This kind of customization of the nine process areas in use is often seen in the work and only aspects that are relevant to the status of the organization in study has been kept.

A translation of a mini CMMI that meets the terminology and language of the organization in the study has been provided and compiled together in Chapter 7. Here where applicable the original names of the process areas defined in CMMI has been kept as is, but those that need more relevance to the nature of the organization are changed, so that their application and target area can be understood better from the given name. The specific goals, specific practices and their relevant sub practices are either altered totally or partially to the relevant needs. Through out this part of the work it is always considered to use the simplest wording as well as providing examples from the working environment at the Faculty so that the people who would want to apply the process improvement initiative in the faculty could easily understand what to do with that part and what does that specific goal of the process area in discussion deals with. This way they could relate the topic easily to the working environment.

Each process area is either taken separately or grouped together when relevant, i.e. Organizational Process Definition and Organizational Process Focus, then analyzed and discussed. The relevant process area's needs and target of application is explained in further details. The current situation concerning the relevant process area in the actual working environment at the faculty is tackled and points that need to be considered while applying the process enhancement initiative is further explained. Chapter 7 is a complementary framework for Chapter 6. In this chapter one reads what process areas to deal with at the target organization and what points need to be prepared. In Chapter 7 one gets to read a framework definition in close terminology to the nature of the organization to boost up the initiative. The following table presents the summerzied list of the chosen process areas and their current capability and potential to reach certain maturity levels if those Process areas are continously improved.

Chosen Process Areas in a Nutshell

#	Process Area	Current CL	Analyzed on	Specific Goal	Specific Practice
1	Requirement Managment	CL 1	6.1 (pp 121-130)	SG 1 Manage Requirements	SP 1.1 Understand Requirements SP 1.2 Obtain Commitment to Requirements SP 1.3 Manage Requirement Changes SP 1.4 Ensure Alignment Between Semester Work and Requirements
2	Syllabi Management	CL 1	6.2 (pp 130-134	SG 1 Establish the Syllabus Management System	SP 1.1 Identify Syllabus Items SP 1.2 Establish a Syllabus Management System
				SG 2 Track and Control Changes	SP 2.1 Track Change Requests SP 2.2 Control Syllabus Items
				SG 3 - Establish Integrity	SP 3.1 Establish Syllabus Management Records
3	Semester Planning	CL 1	6.3 (pp 134-141)	SG 1 - Develop a Semester Plan	SP 1.1 Establish the Schedule

Chosen Process Areas (continued)					
					SP 1.2 Identify Challenges SP 1.3 Plan Data Management SP 1.4 Plan Resources SP 1.5 Plan Needed Knowledge and Skills SP 1.6 Establish the Semester Plan
				SG 2 - Obtain Commitment to the Plan	SP 2.1 Review Plans that Affect the Semester SP 2.2 Reconcile Work and Resource Levels SP 2.3 Obtain Plan commitment
4	Semester Monitoring & Control	CL 1	6.3 (pp 134-141)	SG 1 - Monitor the Semester Against the Plan	SP 1.1 Monitor Semester Planning Parameters SP 1.2 Monitor Commitments SP 1.3 Monitor Semester Challenges SP 1.4 Monitor Data Management SP 1.5 Conduct Progress Review

Chosen Process Areas (continued)					
				SG 2 - Manage Corrective Action to Closure	SP 2.1 Analyze Issues SP 2.2 Take Corrective Action SP 2.3 Manage Corrective Actions
5	Process Quality Assurance	CL 1	6.5 (pp 148-149)	SG 1 - Objectively Evaluate Processes and Work Products SG 2 - Provide Objective Insights	SP 1.1 Ojectively Evaluate Processes SP 1.2 Objectively Evaluate Work Products SP 2.1 Communicate and Resolve Noncompliance Issues SP 2.2 Establish Records
6	Requirement Development	CL 1	6.1 (pp 121-130)	SG 1 - Develop Customer Requirements SG 2 - Develop Product Requirements	SP 1.1 Elicit Needs SP 1.2 Transform Stakeholder Needs into Customer Requirements SP 2.1 Establish Product Requirements

Chosen Process Areas (continued)					
					SP 2.2 Identify Interface Requirements
7	Organizational Process Definition	CL 1	6.4 (pp 141-148)	SG 1 - Establish Organizational Process Assets	SP 1.1 Establish Standard Processes SP 1.2 Establish Organizations Process Asset Library SP 1.3 Establish Work envoirnment Standards SP 1.4 Establish Rules and Guidelines for Teams
8	Organizational Process Focus	CL 1	6.4 (pp 141-148)	SG 1 - Determine Process Improvement Opportunities SG 2 - Plan and Implement Process Actions	SP 1.1 Establish Organizational Process Needs SP 1.2 Appraise the Organization's Processes SP 1.3 Identify the Organization's Process Improvement SP 2.1 Establish Process Action Plans SP 2.2 Implement Process Action Plans

Chosen Process Areas (continued)					
				SG 3 - Deploy Organizational Process Asses and Incorporate Experiences	SP 3.1 Deploy Organizational Process Assets SP 3.2 Deploy Standard Processes SP 3.3 Monitor the Implementation
9	Organizational Training	CL 1	6.6 (pp 150-151)	SG 1 - Establish an Organizational Training Capability	SP 1.1 Establish Strategic Training Needs SP 1.2 Determine which Training Needs are the Responsibility of the Organization SP 1.3 Establish an Organizational Training Tactical Plan SP 1.4 Establish a Training Capability
				SG 2 - Provide Training	SP 2.1 Deliver Training SP 2.2 Establish Training Records SP 2.3 Asses Training Effectiveness

Table 8.1: The summary of the Chosen Process areas and their CL and Potential MLs

The work at hand is a study of the current situation of IT Education in Afghanistan with an attempt on finding possible means of improvement of the IT education system. The Afghan government's plan in providing citizens with access to the recent technological equipment was realized under an emergency approach, faster than the country was ready to receive. This led to the introduction of computer science studies in higher education as an initiative to overcome the lack of local IT experts in the country. Although the establishment of computer science faculties around the country during the last 18 years was accompanied by several challenges, such as the lack of expert, qualified lecturers as well as equipment and a standard curriculum. Several universities around the country have managed to establish those faculties with the help of international universities around the world and have brought those faculties to an established state until today e.g. universities of Herat, Nangarhar, Kandahar and Balkh.

The establishment process of computer science faculties around the country is still at its early stages since 2004. Despite potential establishment problems, they have managed to keep their organizational entities running. Processes are established and already carried out. As per the CMMI definition Capability Level 0 and Level 1 have been reached. This work proposes nine process areas that focus on the improvement of processes within the Computer Science Faculty of Herat University and other computer science faculties around the country. The selection of these nine process areas are the summary of the feedback of colleagues from different computer science faculties around Afghanistan. Their input and participation in the questionnaire supported and helped the author to narrow down the focus to the Process Areas of this selection. However, the structure is general and can be applied to any similar organization around the country. The process areas enjoy the freedom of using other standard tools such as SWOT analysis, Gantt and PERT charts, WBS and some of the ISO standards as basic tools to find out certain improvement opportunities within the process area leading to overall organization improvement. Those interested to undergo the process improvement initiative can plan for their organizational improvement and apply the known standards to improve the processes.

The improvement and institutionalization of these target areas can result in offering quality services to students of computer science studies. The improvement of an IT

educational system provides the young generation with an up to date and systematic access to recent knowledge with which they can further plan their career in jobs as well as further educational levels.

The implementation of such a process enhancement model can support the currently established study programs, i.e. Bachelor degree, and can be used as measuring factor for establishment of further degree programs, i.e. Master degree programs. Any faculty of Computer Science that wants to offer a new field of study program in Bachelor degree should first earn a Level 3 Maturity and those that want to offer Master degree programs and further PhD programs should have a Level 4 Maturity at least. The CMMI framework is a good tool to measure the maturity of a faculty before starting or launching a new study program. The existing entities should be put into focus of further improvement and the processes should be institutionalized before offering new study programs.

As a solution to the challenges and as a means to prepare the faculty to face those challenges, the mini CMMI framework has been suggested.

CMMI on its own is not applicable to the situation of Afghanistan; on the one hand it is a process improvement model for software development, on the other hand, it is foreign to the regulations and administrative structures in Afghanistan. Therefore, a mini CMMI framework that targets the important needs of process improvement initiative in a small organizational entity is introduced. In this mini CMMI, only nine process areas are introduced and their components are customized to the needs of the Computer Science Faculty as an organizational entity that works under the laws and regulations of Afghanistan, hence enhances its adaptability chances. The CMMI framework always concentrates on improvement. The mini CMMI introduced in this work focuses on what processes specific to this organizational entity have to be improved. This work provides further explanation to those keen readers who want to apply this mechanism in their organization; the reasons for why they should focus on these specific nine process areas and how they could use other standard tools to getting the improvement task done, are also explained. For example, let's consider the semester planning process area. It is important to plan ahead of time for a semester in such an educational organization, know the tasks that undergo during the semester execution, know the limitations and challenges and to be

prepared for them when those limitations turn into a problem misconducting the smooth execution of a semester.

The framework that is put together under the clear guidelines of the CMMI helps organizational leaders of this nature with focusing on potential improvement. They get a complete check list of tasks to be carried out, documents and systems to be prepared, provided and established. The work enjoys the freedom of continuous representation of the CMMI framework and when all process areas included in this work reach their optimum capability, then they would all bring the whole organization to a desired maturity level.

The CMMI community and experts who read this work would also probably agree that the work at hand is another example that shows the freedom of CMMI adaptability and flexibility in different organizations. They also get to see that the chosen process areas' components are customized to the actual regulations of the organization in discussion.

Management is the central task for any organizational leader and manager as well as those who run the task itself within the organization. Organizational leaders and managers of educational institutions, specially those dealing with IT Education, can use this work to apply to their daily tasks to improve their organizations. This work's contribution to management helps them see their organizational potentials better; the leveling system in CMMI, which is followed throughout this work as well, sets the process improvement goal as a continual movement that requires their high commitment and support. Moreover, it can serve as a tool that set the basis for achieving those high potential productivity levels of their organization.

It is time for the Afghan administration to step out of the old management systems and try to adopt new methods and new models. The term 'modern administration' is often mistaken as an equivalent to the usage of information technology and the related tools in the organization. This work tries to introduce a new approach to look at an organizational process with a perspective of running the tasks accurately with fewer steps and always finding and enhancing potentials. Saving time, reducing and removing redundant steps for carrying out a task can be institutionalized using the process improvement model proposed in this work. Accountability, transparency and integrity of the processes and tasks that are running in the organizations should

be kept and improved. In addition, a new and modern approach shall be applied.

The lack of documented information is a limitation one often comes across when working in Afghanistan. The explanation on problems and issues in the organizational structures written in this dissertation can be a record for future generations. Several challenges were faced while conducting research. Even though, documentation is mandatory in many parts of the country, it is missing quite often. The lack of proper documentation as well as available and reliable resources were some of the few major obstacles of this dissertation. These challenges were the main factor in selecting the qualitative and self-reflexivity method as the main methods for approaching the compilation of this work.

As far as the author has managed to find out — until realization of this research and compilation of this work — there are no previous attempts in doing a research on finding applicability or adaptability of CMMI in any form in Afghanistan. This work is a unique attempt in adapting and customizing the CMMI as well as introducing the CMMI approaches to be applied in the organizational process improvement within the Afghan organizational structures. It is a proposal to apply process improvement on certain processes so as to yield to an enhanced organization. This research gap could also be seen as a challenge as a comparison to similar attempts could not be drawn. The author hopes this work can provide future researchers a ground to base their investigative work on.

This work lays the grounds for process improvement in IT Educational institutions. It targets improvement in both organizational and educational processes. The process areas selected in this work helps giving the related issues a systematic approach. Running businesses and carrying out tasks within the organization on a daily basis with a primitive idea of survival in the background has to stop in all Afghan organizations. Constant change in information technologies is already a big challenge to those organizations who offer studies in Informatics and computer sciences. These changes require those educational organizations to be prepared for adapting the new changes and providing their students with up to date information and material. An educational entity as such, has to deal with a big challenge already and now if this organization lacks proper organizational systems in act, then obviously it will hardly be able to keep up with the changes. The organization will be always moving slower

than the changes occurring to the technologies around. Computer Science Faculty of Herat University - and also computer science faculties around the country — has passed its "survive for the day" stages. It is now time to lay the grounds for a proper organizational approach to handling the IT education. This work is one proposal to taking new approaches to organizational improvement that could be considered by those in charge.

Introduction of new study programs within the framework of higher educational institutions and universities without a proper study of the market needs, a study of the current available resources — whether human or material — and the availability of proper infrastructure has been something exercised quite often in the past. The country was in need of local IT workforce, but the establishment of faculties around the country followed a rapid maneuver and took place without having the required resources and some still haven't managed to acquire all the needed resources after almost 18 years of establishment . Although, the establishment process of those faculties took place very fast, but the higher education institutions and universities still managed to survive the establishment avalanche.

As the main focus of this study is to introduce new approaches to improve and modernize the management in Afghanistan's administration system using a small organization as a case study, there is no work done in connection to providing suggestions on further improvement in the CMMI model itself. This work focuses on provision of such suggestions as the study's focus is to provide and introduce an alternative approach to the process improvement initiative in the Afghan organizational structure. The CMMI's model is the ultimate potential approach to bringing organizational improvement in Afghanistan.

As the financial system of government institutions in Afghanistan goes through a different channel and there is no financial independence and freedom given to the IT education institutions as a government organization, therefore, this work is also limited to the theoretical implementation and has not touched the financial related processes.

IT educational bodies under the name of computer science faculties have been established around Afghanistan within private and government universities. Herat University's Computer Science Faculty has gone through a 18 year long development

phase since the very beginning. Looking at the IT education as one whole process, this process has been established. Staff members have earned their experience but had to go through rough times. It is time for this faculty to start an initiative on applying new and modern management approaches and start investing in process improvement initiatives.

It is believed that knowing the problem is 50 per cent of the solution to the problem. An improved organization provides better services and saves up a lot of energy and resources in bringing innovative ideas in the organization. The Faculty of Computer Science has a high potential to work on more innovative ideas and the students are keen and ready to contribute to the realization of those ideas. The management needs to save up its time and focus on those potentials; improved processes within the faculty are a key to the realization of this idea.

The immediate action concerning this work is to gain the organizational leadership's commitment to apply this work as a pilot project and record the results for a period of two years at least. Contents of this work can be applied during a rehabilitation project. The findings can then be analyzed in the actual working environment in order to show the decision makers possible enhancement strategies.

Processes involving external stakeholders, for example, reducing the number of documents checking for recruiting new members from six steps of signatory and verification to three steps, requires proper long term planning as several bodies at the MoHE have to be consulted before they can agree on accepting to bring such changes. Improvement to organizational processes, which rely on external stakeholders, requires more time, patience and stays an open challenge for anyone who wants to focus on process improvement with external stakeholders or someone who would want to introduce a process improvement model on the higher management level such as the ministry itself.

Even though every organization has a lot of financial transaction but due to the nature of the organization in this study, this topic has not been touched. Analyzing and introducing a financial independence concept where the universities and faculties could introduce their own means of income generation is another open issue for those readers who would want to work in this regards.

In 2021 a new government was implemented with the sudden takeover of the Tal-

iban in Afghanistan. ”Their reemergence as the governing force has put all achievements related to education, democracy, and human rights in serious risk” ((Ahmadi 2022):16). Having initially announced moderate changes, recent actions, such as controlling and punishing university staff, separate education for male and female students as well as the banning of girls' education, have proven these promises wrong (Ahmadi 2022); (BBC 2021); (Gannon 2022). Most crucial to the new government are the principles of Islam and Sharia; therefore, curricula and syllabi shall be reevaluated according to these norms until a unified Islamic curriculum is installed and put in effect(Ahmadi 2022). How this will be implemented remains to be seen as the new government has not yet initiated any changes (Ibrahim 2021); (Ahmadi 2022):25; (Weiß 2022). Daxner reports ”the Taliban seem to be undecided about many substantial aspects of their higher education policy” (Weiß 2022). Still, first modifications are visible, e.g. at Kabul University where new regulations violate existing laws and rules of higher education. For instance, non-academic people were appointed in academic positions by the Taliban. Moreover, enforcers were sent to universities and female lecturers were prevented from participating in academic life (Ahmadi 2022) :26. All in all, (Ahmadi 2022) sees little hope for higher education in Afghanistan under the new regime. He asks for and recommends support, assistance and solidarity from the international community, also in negotiations of the international community with the Taliban on education in the country. For female students, he suggests online classes if girls and women are no longer allowed in schools and universities (Ahmadi 2022). Also Daxner fears the ”narrowing the intellectual access to sensible disciplines, not only through an Islamist scope, but also because of drying out vivid international relations” as researchers no longer allowed to leave the country, for instance (Weiß 2022).

For now, the development of Afghanistan's higher education seems at a standstill; hence, new models and developments could be considered in the process of reevaluating the educational system. However, the political changes in the country have affected many aspects of life in general and education in specific, but the neutrality of the work at hand benefits from the freedom of adaptability and hence can be still used and applied in the IT Education system, should there be the wish to improve and the right resources be available.

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A
Appendix A

Bachelor Degree Study Programme of Computer Science Faulty as of 2014

Bachelor Degree Study Programme in Computer Science

- Additional courses with 22 CP, as well as
- A Bachelor thesis with 6 CP.

The regular length of the Bachelor degree program is 8 semesters with a total of 153 CP.

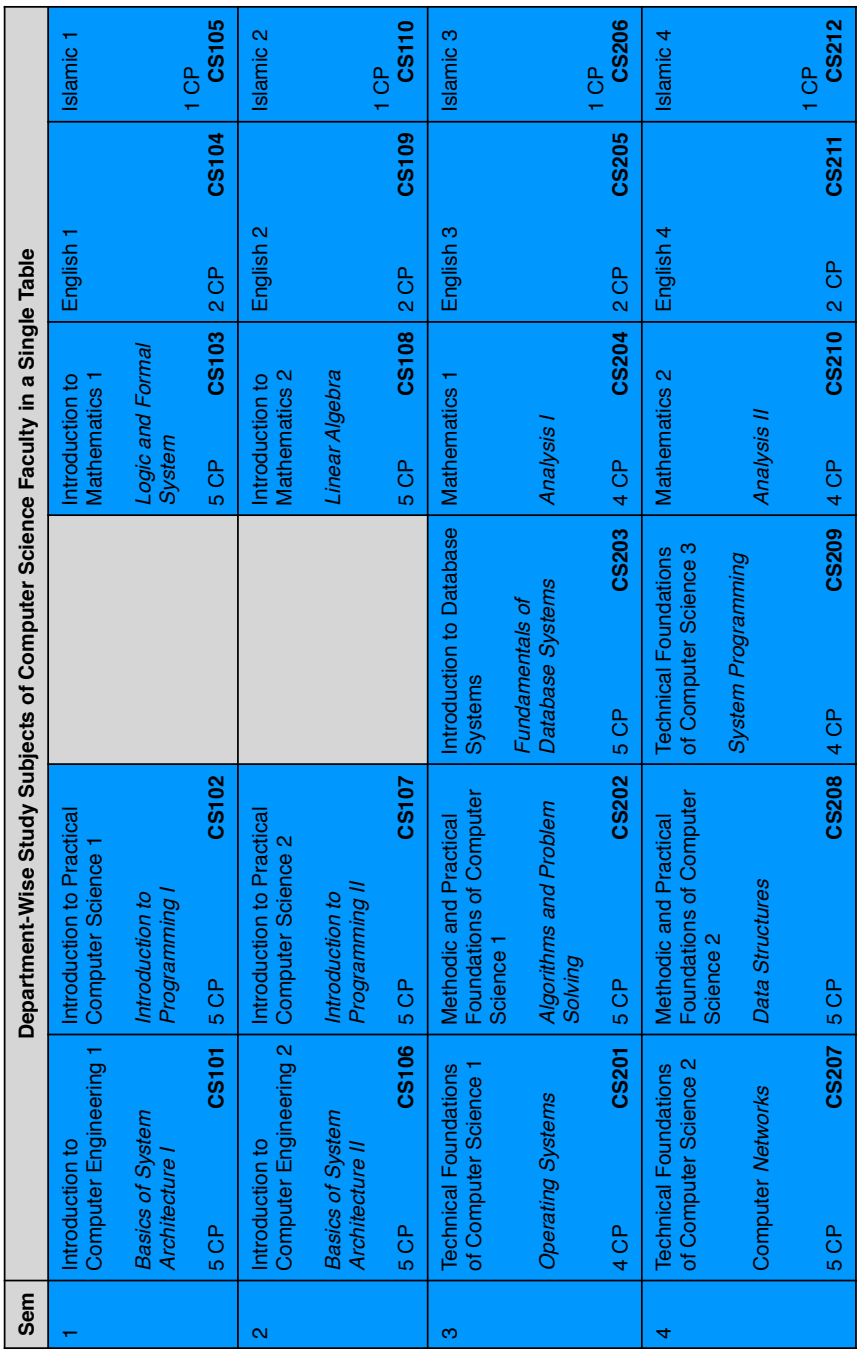
Over view of the Bachelor degree structure

Semester CP	Computer Courses	Additional Courses	
1 to 2 36 CP	Introductory Studies, 30 CP	Islamic Culture, 2 CP English, 4 CP	
3 to 4 42 CP	Basic studies, 36 CP	Islamic Culture, 2 CP English, 4 CP	
5 to 8 75 CP	Professional and Advanced Studies in Each Department 55 CP	Information and Society, Scientific Writing and Management 10 CP	Islamic Culture, 4 CP
	Bachelor Thesis, 6 CP		
153 CP	Total		

The Bachelor degree structure provides for the first two semesters an introduction in the fields of computer engineering, practical computer science, mathematics, islamic culture and English language for a combined 50 CP.

Figure A.1: A General Structure of Study Courses in Computer Science Faculty of Herat University (Peroz and et.al 2014)

Courses and Number of Credits taken in Computer Science Faculty



Sem	Department-Wise Study Subjects of Computer Science Faculty in a Single Table					
1	Introduction to Computer Engineering 1 *Basics of System Architecture I* 5 CP **CS101**	Introduction to Practical Computer Science 1 *Introduction to Programming I* 5 CP **CS102**		Introduction to Mathematics 1 *Logic and Formal System* 5 CP **CS103**	English 1 2 CP **CS104**	Islamic 1 1 CP **CS105**
2	Introduction to Computer Engineering 2 *Basics of System Architecture II* 5 CP **CS106**	Introduction to Practical Computer Science 2 *Introduction to Programming II* 5 CP **CS107**		Introduction to Mathematics 2 *Linear Algebra* 5 CP **CS108**	English 2 2 CP **CS109**	Islamic 2 1 CP **CS110**
3	Technical Foundations of Computer Science 1 *Operating Systems* 4 CP **CS201**	Methodic and Practical Foundations of Computer Science 1 *Algorithms and Problem Solving* 5 CP **CS202**	Introduction to Database Systems *Fundamentals of Database Systems* 5 CP **CS203**	Mathematics 1 *Analysis I* 4 CP **CS204**	English 3 2 CP **CS205**	Islamic 3 1 CP **CS206**
4	Technical Foundations of Computer Science 2 Computer *Networks* 5 CP **CS207**	Methodic and Practical Foundations of Computer Science 2 *Data Structures* 5 CP **CS208**	Technical Foundations of Computer Science 3 *System Programming* 4 CP **CS209**	Mathematics 2 *Analysis II* 4 CP **CS210**	English 4 2 CP **CS211**	Islamic 4 1 CP **CS212**

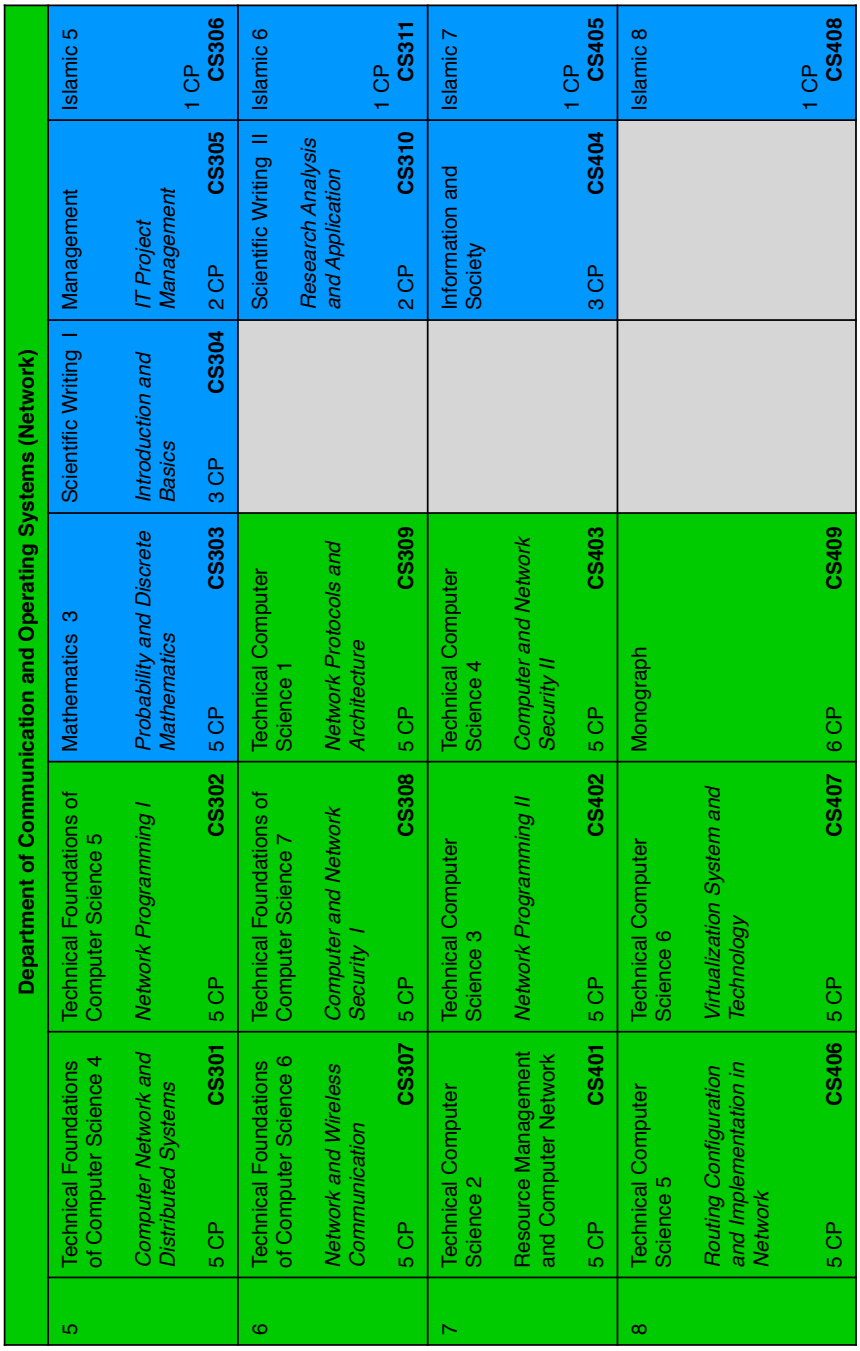
Figure A.2: Details on Basic Courses for all Paricipants of the Bachelor Degree 1st - 4th Semester(Peroz and et.al 2014)

Courses and Number of Credits taken in Computer Science Faculty

Department of Software Engineering					
5	Practical Foundations of Computer Science 1 *Software Engineering I* 5 CP **CS301**	Practical Foundations of Computer Science 2 *Web Engineering I* 5 CP **CS302**	Mathematics 3 *Probability and Discrete Mathematics* 5 CP **CS303**	Scientific Writing I *Introduction and Basics* 3 CP **CS304**	Management *IT Project Management* 2 CP **CS305** 1 CP **CS306**	Islamic 5
6	Practical Foundations of Computer Science 3 *Software Engineering II* 5 CP **CS307**	Practical Computer Science 1 *Web Engineering II* 5 CP **CS308**	Practical Computer Science 2 *Advanced Java Programming* 5 CP **CS309**		Scientific Writing II *Research Analysis and Application* 2 CP **CS310** 1 CP **CS311**	Islamic 6
7	Practical Computer Science 3 *Human Computer Interaction* 5 CP **CS401**	Practical Computer Science 4 *Software Development Life Cycle* 5 CP **CS402**	Practical Computer Science 5 *System Architecture* 5 CP **CS403**		Information and Society 3 CP **CS404** 1 CP **CS405**	Islamic 7
8	Practical Computer Science 6 *Software Engineering III* 5 CP **CS406**	Practical Computer Science 7 Mobile Application Development 5 CP **CS407**	Monograph 6 CP **CS409**			Islamic 8 1 CP **CS408**

Figure A.3: Department Oriented Courses 5th - 8th Semester of the Bachelor Studies(Peroz and et.al 2014)

Courses and Number of Credits taken in Computer Science Faculty



Department of Communication and Operating Systems (Network)					
5	Technical Foundations of Computer Science 4 *Computer Network and Distributed Systems* 5 CP **CS301**	Technical Foundations of Computer Science 5 *Network Programming I* 5 CP **CS302**	Mathematics 3 *Probability and Discrete Mathematics* 5 CP **CS303**	Scientific Writing I *Introduction and Basics* 3 CP **CS304**	Management *IT Project Management* 2 CP **CS305**	Islamic 5 1 CP **CS306**
6	Technical Foundations of Computer Science 6 *Network and Wireless Communication* 5 CP **CS307**	Technical Foundations of Computer Science 7 *Computer and Network Security I* 5 CP **CS308**	Technical Computer Science 1 *Network Protocols and Architecture* 5 CP **CS309**		Scientific Writing II *Research Analysis and Application* 2 CP **CS310**	Islamic 6 1 CP **CS311**
7	Technical Computer Science 2 Resource Management and Computer Network 5 CP **CS401**	Technical Computer Science 3 *Network Programming II* 5 CP **CS402**	Technical Computer Science 4 *Computer and Network Security II* 5 CP **CS403**		Information and Society 3 CP **CS404**	Islamic 7 1 CP **CS405**
8	Technical Computer Science 5 *Routing Configuration and Implementation in Network* 5 CP **CS406**	Technical Computer Science 6 *Virtualization System and Technology* 5 CP **CS407**	Monograph 6 CP **CS409**			Islamic 8 1 CP **CS408**

Figure A.4: Department Oriented Courses 5th - 8th Semester of the Bachelor Studies (Peroz and et.al 2014)

Department of Database and Information Systems						
5	Practical Foundations of Database Systems 1 *Advanced Aspects of Database Systems I* *5 CP* **CS301**	Web-Based Database Applications 1 *Web Engineering I* 5 CP **CS302**	Mathematics 3 *Probability and Discrete Mathematics* 5 CP **CS303**	Scientific Writing 1 *Introduction and Basics* 3 CP **CS304**	IT Management *IT Project Management* 2 CP **CS305**	Islamic 5 1 CP **CS306**
6	Practical Foundations of Database Systems 2 *Advanced Aspects of Database Systems II* 5 CP **CS307**	Web-Based Database Applications 2 *Web Engineering II* 5 CP **CS308**	Practical Database Systems I *Introduction to Human Computer Interaction* 5 CP **CS309**		Scientific Writing II *Research Analysis and Application* 2 CP **CS310**	Islamic 6 1 CP **CS311**
7	Advance Studies in Database Systems 1 *Data Warehousing and Data Mining* 5 CP **CS401**	Web-Based Database Applications 3 *Web Engineering III* 5 CP **CS402**	Practical Database Systems 2 Cross-Platform Mobile Development 5 CP **CS403**		Information and Society 3 CP **CS404**	Islamic 7 1 CP **CS405**
8	Advance Studies in Database Systems 2 *Modern Special Purpose Database System* 5 CP **CS406**	Web-Based Database Applications 4 *Modern Programming Paradigms in Web Development* 5 CP **CS407**	Monograph 6 CP **CS409**			Islamic 8 1 CP **CS408**

Figure A.5: Department Oriented Courses 5th - 8th Semester of the Bachelor Studies (Peroz and et.al 2014)

B
Appendix B

List of Private and Government Universities in Afghanistan

Afghan Government Universities - 2016

No.	Name	Year	has CS?
1	Kabul University	1932	Yes
2	Kabul Poly-Technical University	1963	Yes
3	Kabul Medical University	1932	No
4	Kabul Education University	1964	Yes
5	Sheikh Zayed's Khost University	1999	Yes
6	Ghazni University	2008	No
7	Paktia University	2004	No
8	Nangarhar University	1963	Yes
9	Takhar (Abdullah ebn Masud) University	1991	No
10	Balkh University	1986	Yes
11	Herat University	1988	Yes
12	Kandahar University	1990	Yes
13	Bamian University	1996	No
14	Albironi University	1998	No
15	Laghman University	?	No
16	Konar University	?	No
17	Faryab University	?	No
18	Parwan University	?	No
19	Badakhshan University	1987	No
20	Baghlan University	1992	No
21	Samangan Higher Education Institution	?	No
22	Jawzjan University	1994	No
24	Ghour Higher Education Institution	?	No
25	Panjshier Higher Education Institution	?	No

26	Helmand University	?	No

Table B.1: State Run Universities/Higher Education Institutions in Afghanistan (MoHE 2014a)

Private Universities in Afghanistan - 2016

No.	Name	has CS?	Remarks
1	Kardan Private University	Yes	Master in other fields
2	Afghan American Private University	No	
3	Bakhtar Private University	Yes	Master in CS and other
4	Afghan American University	Yes	
5	Maiwand Private Higher Education Institution	Yes	
6	Kateb Private University	Yes	Master in other fields
7	Cheragh Medical Private Higher Education Institution	No	
8	Maryam Private Higher Education Institution	Yes	
9	Khatam-ol Nabiein Private University	Yes	Master in other fields
10	Pieshgam Private Higher Education Institution	No	
11	Khawaran Private Higher Education Institution	No	Suspended
12	Dawat Private University	No	Master in other fields
13	Rana Private Higher Education Institution	Yes	
14	Donya Private University	No	Master in other fields
15	Spin Ghar Private Higher Education Institution - Kabul Branch	No	
16	Sallam Private University	Yes	Master in other fields
17	Tabesh Private Higher Education Institution	No	
18	Karawan Private University	Yes	
19	Mash'al Private University	No	
20	Khan-e Noor Private Higher Education Institution	Yes	
21	Tolo-e Aftab Private Higher Education Institution	Yes	

22	Gharjestan Private University	Yes	
23	Sayed Jamaloddin Afghan Private Higher Education Institution	No	
24	Ebn-e Sina Private University	Yes	Master in other fields
25	Iranian Free Islamic University - Kabul Branch	No	Master in other fields
26	Gawharshad Private Higher Education Institution	No	
27	Azhar Private Higher Education Institution	No	
28	Kabora Private Higher Education Institution	No	
29	Khwarazmi Private Higher Education Institution	Yes	
30	Ghaleb University - Kabul Branch	No	
31	Ariana Private Higher Education Institution - Kabul Branch	No	
32	Jam-e Al Mostafa Private Higher Education Institution	No	
33	Payame Noor Private University	No	
34	Maihan Private Higher Education Institution	No	
35	Orouj Private Higher Education Institution	No	
36	Rabea Balkhi Private Higher Education Institution	Yes	
37	Afghan Private Higher Education Institution	No	
38	Sharq Private Higher Education Institution	Yes	
39	Mielli Private Higher Education Institution	No	
40	Afghan-Swiss Private Higher Education Institution	No	
41	Payam Private Higher Education Institution	No	
42	Zawal Private Higher Education Institution	No	
43	Esteqamat Private Higher Education Institution	No	
44	Jahan Private Higher Education Institution	Yes	
45	Afghanistan Private Higher Education Institution	No	
46	Esteqlal Private Higher Education Institution	Yes	
47	Uomf-Swiss Private University - Kabul Branch	No	Master in other fields

48	Edraak Private Higher Education Institution	No	
49	Ahl-e Bayt Private Higher Education Institution	No	
50	Fanoos Private Higher Education Institution	No	
51	Ashnaa Private Higher Education Institution	No	
52	Bayan Private Higher Education Institution	No	
53	Ghazi Amanollah Khan Private Higher Education Institution	Yes	
54	Alama Private Higher Education Institution	Yes	
55	Abo Raihan Private Higher Education Institution	No	
56	Abo Raihan Private Higher Education Institution	No	
57	Shafa Private Higher Education Institution	No	
58	Niestan Private Higher Education Institution	No	
59	Khorshid Private Higher Education Institution	No	
60	Qalam Private Higher Education Institution	No	
61	Ne'aman Sadaat Private Higher Education Institution	No	
62	Afghan Pamir Private Higher Education Institution	No	
63	Saber Private Higher Education Institution	No	
64	Bayazi Roshan Private Higher Education Institution	No	
65	Razi Private Higher Education Institution	No	
66	Asas Private Higher Education Institution	No	
67	Noorin Private Higher Education Institution	No	
68	Ebn-e Khaldoon Private Higher Education Institution	No	

Private Universities Located in Balkh Province

69	Mawlana Jalal-oddin Balkhi Private Higher Education Institution	No	
70	Sadaat Private Higher Education Institution	Yes	
71	Aria Private University	Yes	
72	Taj Private Higher Education Institution	No	
73	Rah-e Sa'adat Private Higher Education Institution	No	
74	Ebn-e Siena Private Higher Education Institution - Balkh Branch	No	
75	Kawoun Private Higher Education Institution	No	

76	Rahnaward Private Higher Education Institution	No	
77	Turkistan Private Higher Education Institution	No	
78	Alborz Private Higher Education Institution	No	
	Private Universities Located in Takhar Province		
79	Fajrestan Private Higher Education Institution	No	
80	Rah-e Sa'adat Private Higher Education Institution - Takhar Branch	No	
81	Khana-e Danesh Private Higher Education Institution	No	
82	Payman Private Higher Education Institution	No	
	Private Universities Located in Baghlan Province		
83	Hakim Sana'ie Private University	No	
84	Royan Private Higher Education Institution	No	
85	Qods Private Higher Education Institution	No	
	Private Universities Located in Parwan Province		
86	Danesh Private Higher Education Institution	No	
	Private Universities Located in Konar Province		
87	Tanwier Private Higher Education Institution	No	
	Private Universities Located in Ghazni Province		
88	Khatam-al Nabien Private Higher Education Institution - Ghazni Branch	No	
89	Khatam-al Nabien Jaghori Private Higher Education Institution	No	
90	Sultan Mahmud Ghaznawi Private Higher Education Institution	No	
91	Moslim Private Higher Education Institution	No	
	Private Universities Located in Niemroz Province		
92	Barack Private Higher Education Institution	No	
	Private Universities Located in Konduz Province		
93	Sallam Private University - Konuz Branch	No	
94	Shamal Private Higher Education Institution	No	
95	Namr Private Higher Education Institution	No	
96	Kohandazh Private Higher Education Institution	No	
97	Shahid Sayed Jan Private Higher Education Institution	No	
98	Imam Shaibany Private Higher Education Institution	No	
	Private Universities Located in Nangarhar Province		
99	Khorasan Private University	Yes	

100	Spin Ghar Private Higher Education Institution	No	
101	Ariana Private Higher Education Institution	No	
102	Al-Falah Private University	No	
103	Roshan Private Higher Education Institution	No	
104	Al-Taqwa Private Higher Education Institution	No	

Private Universities Located in Herat Province

1045	Eshraq Private Higher Education Institution	No	
106	Ghaleb Private University	Yes	
107	Jami University	No	
108	Asia Private Higher Education Institution	No	
109	Khaja Abdullah Ansari Private Higher Education Institution	Yes	
110	Al-Ghiyas Private Higher Education Institution	No	
111	Kahkashan-e Sharq Private Higher Education Institution	No	
112	Hariwa Private Higher Education Institution	Yes	
113	Atefi Private Higher Education Institution	No	

Private University Located in Paktia Province

114	Zam Zam Private Higher Education Institution	No	

Private Universities Located in Khost Province

115	Pamier Private Higher Education Institution	No	
116	Ahmad Shah Abdali Private Higher Education Institution	No	
117	Dawat Private Higher Education Institution - Khost Branch	No	
118	Tolo-e Aftab Private Higher Education Institution - Khost Branch	No	

Private Universities Located in Helmand Province

119	Wadi Helmand Private Higher Education Institution	No	
120	Arakoziya Private Higher Education Institution	No	
121	Bost Private University	Yes	

Private Universities Located in Jowzjan Province

122	Amir Ali Sher-e Nawaie Private Higher Education Institution	No	
123	Matanat Private Higher Education Institution	No	

124	Barlas Private Higher Education Institution	No	
	Private Universities Located in Kandahar Province		
125	Mirwais Nieka Private Higher Education Institution	No	
126	Malalai Private Higher Education Institution	No	
127	Binawa Private Higher Education Institution	Yes	
128	Saba Private Higher Education Institution	Yes	
	Private Universities Located in Badakhshan Province		
129	Barna Private Higher Education Institution	No	
	Private Universities Located in Samangan Province		
130	Mawlana Jalal-oddin Mohammad Balkhi Private Higher Education Institution	No	
	Private Universities Located in Bamian Province		
131	Bamika Private Higher Education Institution	No	
	Private Universities Located in Maidan-Wardak Province		
132	Tabesh Private Higher Education Institution	No	
	Private Universities Located in Badghis Province		
133	Hanzala Private Higher Education Institution	No	
134	Hekmat Private Higher Education Institution	No	
	Private Universities Located in Farah Province		
135	Gharjestan Private Higher Education Institution	Yes	
136	Abo-Nassr Private Higher Education Institution	No	
	Private Universities Located in Faryab Province		
137	Rashad Private Higher Education Institution	No	

Table B.2: Total number of students engaged in higher education studies in Afghanistan (MoHE 2014a)

C
Appendix C

Here is a sample syllabus structure taken from the set of Syllabus files available at the Faculty of Computer Science. The subject is Operating Systems belonging to the core module of Technical Foundations of Computer Science. The objective of the module is to build the technical foundations for students who are willing to pursue their major in the Communications and Operating Systems Department. However, since this is a fundamental subject to all the majors, within the Computer Science Faculty's study program for Bachelor studies, therefore students of all majors have to take this mandatory course.
The following pages serve just as an example to give readers how does a Syllabus is developed and maintained in the Faculty. It is mainly Word documents turned into PDF files and distributed to colleagues, who are dealing with the subject. Students hardly get a copy of the syllabus.

COURSE SYLLABUS

DEPARTMENT :	Communication and Operating Systems
COURSECODE :	CS201
Course Title:	Technical Foundations of Computer Science 1
Subtitle:	Operating Systems
Prerequisite	: CS101 – Computer Engineering I
Prerequisite to	: CS209 – Technical Foundations of Computer Science III
Number of Credits	: 4 CP
Type of Course	: Basic Course
Faculty	: Computer Science Faculty
Term/Time/Room	: Semester 3, SY 2015, Room 1
Lecturer	: Hamid Rahman Mohmand
Contact	: rahmanhm@gmail.com
Course Description	: Introduction to Operating Systems and Design Principles

Objectives:

- Understand Operating Systems concept
- Be able to distinguish between different system architectures
- Understand main functionalities of an Operating System
- Describe various scheduling algorithms
- Differentiate between kernel space and user space
- Define and understand process, threads and its associate information

Topics:

- Computer Architecture Overview
- Process and Process Management
- Concurrency, synchronization and communication
- Scheduling
- Memory Management
- Storage Management
    - Total number of hours required per semester is **64** hours

Teaching Methods/Strategies:

- Lecture presentation
- Exercises
    - Assignments to be carried out in groups at home
    - Debriefing
    - Q&A

- Tutorial
  - Q&A
  - Panel discussions

Requirements:
Students are required to study the text material for the whole course content to be able to carry out all the workload. They should allocate 3 hours time for each session to understand and cover the course topic. Allocation of an extra 3 hours for solving exercise problems is required as well.

Assessment:
The following scheme will be used to evaluate students' progress during the semester:

- Exercises: 20 %
- Mid-Term Exam: 20 %
- Final Exam: 60 %

Students will have to write for both "Mid-Term and Final" exams.

Text / Reference:
- Stallings, William; Operating Systems: Internal and Design Principles, 6th Ed.
- Selberschatz, Abraham; et. al; Operating System Concepts; 7th Ed.
- Selberschatz, Abraham; et. al; Operating System Concepts with Java; 6th Ed.
- Articles and quick guides
  - The Unix Operating System by William Stallings
  - The Windows Operating System by William Stallings
  - The Linux Operating System by William Stallings
  - Basic Math Refresher by William Stallings
  - Number System by William Stallings
  - Queuing Analysis by William Stallings
  - C and C++ in 5 Day by Philip Machannick

The PDF version of the aforementioned material is available and accessible by students through the Local server of the faculty. However, students are encouraged to buy the first item of the list, as it will be used as the main resource for the course.

COURSE OUTLINE

Schedule	Details of Course Activity
Session 0	**Course Orientation** Class policies and Organizational Issues Group Division and Introduction to the topic
Session 1	**Lecture:** Computer System Overview – I (Chapter 1) • Basic Elements • Processor Registers - User visible registers - Control and Status registers • Interrupts - Interrupts and Interrupts cycle - Interrupt processing - Multiple Interrupts - Multiprogramming
Session 2	**Lecture:** Computer System Overview – II (Chapter 1) • The Memory Hierarchy • Cache Memory - Motivation - Cache principles - Cache Design • I/O Communication Techniques - Programmed I/O - Interrupt-Driven I/O - Direct Memory Access **Recommended reading for Session 1 & 2:** - Denning, P. "The Locality Principle" Communications of the ACM, July 2005. - Hennessy, J., and Patterson, D. Computer Architecture: A Quantitative Approach. San Mateo, CA: Morgan Kaufmann, 2007. - Patterson, D., and Hennessy, J. Computer Organization and Design: The Hardware/ Software Interface. San Mateo, CA: Morgan Kaufmann, 2007. - Stallings, W. Computer Organization and Architecture, 7th ed. Upper Saddle River, NJ: Prentice Hall, 2006.
Session 3	**Lecture:** Operating System Overview – I (Chapter 2) • Operating System Objectives and Functions - The Operating System as a User/Computer Interface - The Operating System as Resource Manager - Ease of Evaluation of an Operating System • The Evolution of an Operating System - Serial Processing - Simple Batch Systems - Multiprogrammed Batch Systems - Time-Sharing Systems • Major Achievements - The Process - Memory Management - Information Protection and Security - Scheduling and Resource Management - System Structure

	• Development leading to modern operating systems
Session 4	**Lecture:** Operating System Overview II (Chapter 2) • Microsoft Windows Overview - History - Single-User Multi tasking - Architecture - Client/Server Model - Threads and SMP - Windows Objects • Traditional Unix Systems - History - Description • Modern Unix Systems - System V Release 4 (SVR4) - BSD - Solaris 10 • Linux - History - Modular Structure - Kernel Components **Recommended Reading for Session 3 & 4:** - Bovet, D., and Cesati, M. Understanding the Linux Kernel. Sebastopol, CA: O'Reilly, 2006. - Brinch Hansen, P. Classic Operating Systems: From Batch Processing to Distributed Systems. New York: Springer-Verlag, 2001. - Goodheart, B., and Cox, J. The Magic Garden Explained: The Internals of UNIX System V Release 4. Englewood Cliffs, NJ: Prentice Hall, 1994. - Love, R. Linux Kernel Development. Waltham, MA: Novell Press, 2005. MCDO07 McDougall, R., and Mauro, J. Solaris Internals: Solaris 10 and OpenSolaris Kernel Architecture. Palo Alto, CA: Sun Microsystems Press, 2007. - McKusick, M., and Neville-Neil, J. The Design and Implementation of the FreeBSD Operating System. Reading, MA: Addison-Wesley, 2005. - Russinovich, M., and Solomon, D. Microsoft Windows Internals: Microsoft Windows Server(TM) 2003, Windows XP, and Windows 2000. Redmond, WA: Microsoft Press, 2005. - Swaine, M. "Wither Operating Systems?" Dr. Dobb's Journal, March 2007. VAHA96 Vahalia, U. UNIX Internals: The New Frontiers. Upper Saddle River, NJ: Prentice Hall, 1996.
Session 5	**Lecture:** Process Description and Control – I (Chapter 3) • What is a Process? - Background information on Process - Process and Process Control Blocks • Process States - A Two-State Process Model - The Creation and Termination of Processes - A Five-State Process Model - Suspended Processes
Session 6	**Lecture:** Process Description and Control – II (Chapter 3) • Process Description - Operating System Control Structures - Process Control Structures

Session 7	**Lecture:** Process Description and Control – III (Chapter 3) • Process Control - Modes of Execution - Process Creation - Process Switching • Execution of the Operating System - No process Kernel - Execution within User Processes - Process-Based Operating System
Session 8	**Lecture:** Process Description and Control – IV (Chapter 3) • Security Issues - System Access Threats - Countermeasures • Unix SVR4 Process Management - Process States - Process Description - Process Control **Recommended Reading for Session 6, 7, 8 and 9:** - Goodheart, B., and Cox, J. The Magic Garden Explained: The Internals of UNIX System V Release 4. Englewood Cliffs, NJ: Prentice Hall, 1994. - Gray, J. Interprocess Communications in UNIX: The Nooks and Crannies. Upper Saddle River, NJ: Prentice Hall, 1997. - Nehmer, J. "Dispatcher Primitives for the Construction of Operating System Kernels." Acta Informatica, vol 5, 1975.
Session 9	**Lecture:** Threads, SMP and Microkernels – I (Chapter 4) • Processes and Threads - Multithreading - Thread Functionality - Example – Adobe PageMaker - User-Level and Kernel-Level Threads
Session 10	**Lecture:** Threads, SMP and Microkernels – II (Chapter 4) • Symmetric Multiprocessing - SMP Architecture - SMP Organization - Multiprocessor Operating System Design Considerations
Session 11	**Lecture:** Threads, SMP and Microkernels – III (Chapter 4) • Microkernels - Microkernel Architecture - Benefits of a Microkernel Organization - Microkernel Performance - Microkernel Design • Windows Thread and SMP Management - Process and Thread Objects - Multithreading - Thread States - Support for OS Subsystems - Symmetric Multiprocessing Support

Session 12	**Lecture:** Threads, SMP and Microkernels – IV (Chapter 4) • Solaris Thread and SMP Management - Multithreaded Architecture - Motivation - Process Structure - Thread Execution - Interrupts as Threads • Linux Process and Thread Management - Linux Tasks - Linux Threads **Recommended Reading for Sessions 11, 12, 13 & 14:** - Chapin, S., and Maccabe, A., eds. "Multiprocessor Operating Systems: Harness- ing the Power." special issue of IEEE Concurrency, April–June 1997. - Kleiman, S.; Shah, D.; and Smallders, B. Programming with Threads. Upper Saddle River, NJ: Prentice Hall, 1996. - Lewis, B., and Berg, D. Threads Primer. Upper Saddle River, NJ: Prentice Hall, 1996. - Liedtke, J. "On μ-Kernel Construction." Proceedings of the Fifteenth ACM Symposium on Operating Systems Principles, December 1995. - Liedtke, J. "Toward Real Microkernels." Communications of the ACM, September 1996. - Mukherjee, B., and Karsten, S. "Operating Systems for Parallel Machines." In Parallel Computers: Theory and Practice. Edited by T. Casavant, P. Tvrkik, and F. Plasil. Los Alamitos, CA: IEEE Computer Society Press, 1996. - Pham, T., and Garg, P. Multithreaded Programming with Windows NT. Upper Saddle River, NJ: Prentice Hall, 1996. - Robbins, K., and Robbins, S. UNIX Systems Programming: Communication, Concurrency, and Threads. Upper Saddle River, NJ: Prentice Hall, 2004.
Session 13 & 14	**Exercise:** Revision and Solutions
Session 15	**Lecture:** Concurrency: Mutual Exclusion and Synchronization – I (Chapter 5) • Principles of Concurrency - A Simple Example - Race Condition - Operating System Concerns - Process Interaction - Requirements for Mutual Exclusion
Session 16	**Lecture:** Concurrency: Mutual Exclusion and Synchronization – II (Chapter 5) • Mutual Exclusion: Hardware Support - Interrupt Disabling - Special Machine Instructions
Session 17	**Lecture:** Concurrency: Mutual Exclusion and Synchronization – III (Chapter 5) • Semaphores - Mutual Exclusion - The Producer/Consumer Problem - Implementation of Semaphores
Session 18	**Lecture:** Concurrency: Mutual Exclusion and Synchronization – IV (Chapter 5) • Monitors - Monitor with Signal - Alternate Model of Monitors with Notify and Broadcast

<table>
<tr><td>Session 19</td><td>Lecture: Concurrency: Mutual Exclusion and Synchronization – V (Chapter 5)
• Message Passing
- Synchronization
- Addressing
- Message Format
- Queuing Discipline
- Mutual Exclusion
• Readers/Writers Problem
- Readers Have Priority
- Writers Have Priority

Recommended Reading for Session 16, 17, 18, 19 & 20:
- Andrews, G., and Schneider, F. “Concepts and Notations for Concurrent Programming.” Computing Surveys, March 1983.
- Axford, T. Concurrent Programming: Fundamental Techniques for Real-Time and Parallel Software Design. New York: Wiley, 1988.
- Bacon, J., and Harris, T. Operating Systems: Concurrent and Distributed Software Design. Reading, MA: Addison-Wesley, 1998.
- Ben-Ari, M. Principles of Concurrent Programming. Englewood Cliffs, NJ: Prentice Hall, 1982.
- Ben-Ari, M. Principles of Concurrent and Distributed Programming. Englewood Cliffs, NJ: Prentice Hall, 1990.
- Birrell, A. An Introduction to Programming with Threads. SRC Research Report 35, Compaq Systems Research Center, Palo Alto, CA, January 1989. Available at http://www.research.compaq.com/SRC
- Buhr, P., and Fortier, M. “Monitor Classification.” ACM Computing Surveys, March 1995.
- Downey, A. The Little Book of Semaphores. www.greenteapress.com/semaphores/
- Hoare, C. Communicating Sequential Processes. Englewood Cliffs, NJ: Prentice- Hall, 1985.
- Kang, S., and Lee, J. “Analysis and Solution of Non-Preemptive Policies for Scheduling Readers and Writers.” Operating Systems Review, July 1998.
- Lamport, L. “The Mutual Exclusion Problem.” Journal of the ACM, April 1986.
- Raynal, M. Algorithms for Mutual Exclusion. Cambridge, MA: MIT Press, 1986.
- Rudolph, B. “Self-Assessment Procedure XXI: Concurrency.” Communications of the ACM, May 1990.</td></tr>
<tr><td>Session 20</td><td>Exercise: Revision</td></tr>
<tr><td>Session 21</td><td>Exercise: Revision and Class Discussion</td></tr>
<tr><td>Session 22</td><td>Lecture: Concurrency: Deadlock and Starvation – I (Chapter 6)
• Principles of Deadlock
- Reusable Resources
- Consumable Resources
- Resource Allocation Graphs
- The Conditions for Deadlock
• Deadlock Prevention
- Mutual Exclusion
- Hold and Wait
- No Preemption
- Circular Wait</td></tr>
<tr><td>Session 23</td><td>Lecture: Concurrency: Deadlock and Starvation – II (Chapter 6)
• Deadlock Avoidance
- Process Initiation Denial</td></tr>
</table>

	- Resource Allocation Denial • Deadlock Detection - Deadlock Detection Algorithm - Recovery
Session 24	**Lecture:** Concurrency: Deadlock and Starvation – III (Chapter 6) • An Integrated Deadlock Strategy • Dinning Philosophers Problem - Solution Using Semaphores - Solution Using a Monitor
Session 25	**Lecture:** Concurrency: Deadlock and Starvation – IV (Chapter 6) • Unix Concurrency Mechanisms - Shared Memory - Semaphores - Signals • Linux Kernel Concurrency Mechanisms - Atomic Operations - Spinlocks - Semaphores - Barriers -
Session 26	**Lecture:** Concurrency: Deadlock and Starvation – V (Chapter 6) • Solaris Thread Synchronization Primitives - Mutual Exclusion Lock - Semaphores - Readers/Writers Lock - Condition Variables • Windows Concurrency Mechanisms - Wait Functions - Dispatcher Objects - Critical Sections - Slim Read-Writers Locks and Condition Variables **Recommended Reading for Session 21, 22, 23, 24 & 25:** - Abramson, T. "Detecting Potential Deadlocks." Dr. Dobb's Journal, January 2006. - Coffman, E.; Elphick, M.; and Shoshani, A. "System Deadlocks." Computing Sur- veys, June 1971. - Corbett, J. "Evaluating Deadlock Detection Methods for Concurrent Software." IEEE Transactions on Software Engineering, March 1996. - Dimitoglou, G. "Deadlocks and Methods for Their Detection, Prevention, and Recovery in Modern Operating Systems." Operating Systems Review, July 1998. - Gray, J. Interprocess Communications in UNIX: The Nooks and Crannies. Upper Saddle River, NJ: Prentice Hall, 1997. - Holt, R. "Some Deadlock Properties of Computer Systems." Computing Surveys, September 1972. - Isloor, S., and Marsland, T. "The Deadlock Problem: An Overview." Computer, September 1980. - Levine, G. "Defining Deadlock." Operating Systems Review, January 2003. - Levine, G. "Defining Deadlock with Fungible Resources." Operating Systems Review, July 2003. - Love, R. Linux Kernel Development. Indianapolis, IN: Novell Press, 2005. - McDougall, R., and Mauro, J. Solaris Internals: Solaris 10 and OpenSolaris

	Kernel Architecture. Palo Alto, CA: Sun Microsystems Press, 2007. - Shub, C. "A Unified Treatment of Deadlock." Journal of Computing in Small Colleges, October 2003. Available through the ACM digital library.
Session 27	**Exercise:** Class Discussion, Group Work and Revision
Session 28	**Exercise:** Class Discussion, Group Work and Revision
Session 29	**Mid-Term Exam**
Session 30	**Mid-Term Exam**
Session 31	**Lecture:** Memory Management – I (Chapter 7) • Memory Management Requirements - Relocation - Protection - Sharing - Logical Organization - Physical Organization • Memory Partitioning - Fixed Partitioning - Dynamic Partitioning - Buddy System - Relocation
Session 32	**Lecture:** Memory Management – II (Chapter 7) • Paging • Segmentation • Security Issues - Buffer Overflow Attacks - Defending against Buffer Overflows **Recommended Reading for Session 26 & 27:** - Beck, L. System Software. Reading, MA: Addison-Wesley, 1997. - Clarke, D., and Merusi, D. System Software Programming: The Way Things Work. Upper Saddle River, NJ: Prentice Hall, 1998. - Knuth, D. The Art of Computer Programming, Volume 1: Fundamental Algorithms. Reading, MA: Addison-Wesley, 1997. - Levine, J. Linkers and Loaders. San Francisco: Morgan Kaufmann, 2000. - Milenkovic, M. Operating Systems: Concepts and Design. New York: McGrawHill, 1992.
Session 33 & 34	**Exercise:**
Session 35	**Lecture:** Virtual Memory – I (Chapter 8) • Hardware and Control Structures - Locality and Virtual Memory - Paging - Segmentation - Combined Paging and Segmentation - Protection and sharing
Session 36	**Lecture:** Virtual Memory – II (Chapter 8) • Operating System Software - Fetch Policy - Replacement Policy - Resident Set Management - Cleaning Policy - Load Control
Session 37	**Lecture:** Virtual Memory – III (Chapter 8)

	• Unix and Solaris Memory Management - Paging System - Kernel Memory Allocator
Session 38	**Lecture:** Virtual Memory – IV (Chapter 8) • Linux Memory Management - Linux Virtual Memory - Kernel Memory Allocation
Session 39	**Lecture:** Virtual Memory – V (Chapter 8) • Windows Memory Management - Windows Virtual Address Map - Windows Paging **Recommended Reading for Sessions 28, 29, 30, 31 & 32:** - Carr, R. Virtual Memory Management. Ann Arbor, MI: UMI Research Press, 1984. - Denning, P. "Virtual Memory." Computing Surveys, September 1970. - Dowdy, L., and Lowery, C. P.S. to Operating Systems. Upper Saddle River, NJ: Prentice Hall, 1993. - Gorman, M. Understanding the Linux Virtual Memory Manager. Upper Saddle River, NJ: Prentice Hall, 2004. - IBM National Technical Support, Large Systems. Multiple Virtual Storage (MVS) Virtual Storage Tuning Cookbook. Dallas Systems Center Technical Bulletin G3200597, June 1986. - Jacob, B., and Mudge, T. "Virtual Memory: Issues of Implementation." Computer, June 1998. JACO98b Jacob, B., and Mudge, T. "Virtual Memory in Contemporary Microprocessors." IEEE Micro, August 1998. - Milenkovic, M. Operating Systems: Concepts and Design. New York: McGraw-Hill, 1992. - Vahalia, U. UNIX Internals: The New Frontiers. Upper Saddle River, NJ: Prentice Hall, 1996.
Session 40	**Exercise:**
Session 41	**Exercise:**
Session 42	**Lecture:** Uniprocessor Scheduling – I (Chapter 9) • Types of Processor Scheduling - Long-Term Scheduling - Medium-Term Scheduling - Short-Term Scheduling
Session 43	**Lecture:** Uniprocessor Scheduling – II (Chapter 9) • Scheduling Algorithms - Short-Term Scheduling Criteria - The Use of Priorities - Alternative Scheduling Policies - Performance Comparison - Fair-Share Scheduling
Session 44	**Lecture:** Uniprocessor Scheduling – III (Chapter 9) • Traditional UNIX Scheduling **Recommended Reading for Session 33, 34 and 35:** - Conway, R.; Maxwell, W.; and Miller, L. Theory of Scheduling. Reading, MA: Addison-Wesley, 1967. Reprinted by Dover Publications, 2003. - Dowdy, L., and Lowery, C. P.S. to Operating Systems. Upper Saddle River, NJ: Prentice Hall, 1993.

	- Kleinrock, L. Queuing Systems, Volume Three: Computer Applications. New York: Wiley, 2004.
Session 45	**Exercise:** Class work, Revision
Session 46	**Exercise:** Class Work, Revision
Session 47	**Lecture:** I/O Management and Disk Scheduling – I (Chapter 11) • I/O Devices • Organization of the I/O Function
Session 48	**Lecture:** I/O Management and Disk Scheduling – II (Chapter 11) • Operating System Design Issues - Design Objectives - Logical Structure of the I/O Function • I/O Buffering - Single Buffer - Double Buffer - Circular Buffer - The Utility of Buffering
Session 49	**Lecture:** I/O Management and Disk Scheduling – III (Chapter 11) • Disk Scheduling - Disk Performance Parameters - Disk Scheduling Policies • Raid
Session 50	**Lecture:** I/O Management and Disk Scheduling – IV (Chapter 11) • Disk Cache - Design Considerations - Performance Considerations • Unix SRV4 I/O - Buffer Cache - Character Queue - Buffered I/O - Unix Devices
Session 55	**Lecture:** I/O Management and Disk Scheduling – V (Chapter 11) • Linux I/O - Disk Scheduling - Linux Page Cache • Windows I/O - Basic I/O Facilities - Asynchronous and Synchronous I/O - Software RAID - Volume Shadow Copies - Volume Encryption **Recommended Reading for Sessions 43, 44, 45, 46 & 47:** - Cao, P.; Felten, E.; Karlin, A.; and Li, K. "Implementation and Performance of Integrated Application-Controlled File Caching, Prefetching, and Disk Scheduling." ACM Transactions on Computer Systems, November 1996. - Chen, P.; Lee, E.; Gibson, G.; Katz, R.; and Patterson, D. "RAID: High-Performance, Reliable Secondary Storage." ACM Computing Surveys, June 1994. - Chen, S., and Towsley, D. "A Performance Evaluation of RAID Architectures."IEEE Transactions on Computers, October 1996 - Dalton, W., et al. Windows NT Server 4: Security, Troubleshooting, and

		Optimization. Indianapolis, IN: New Riders Publishing, 1996. - Dekker, E., and Newcomer, J. Developing Windows NT Device Drivers: A Programmer's Handbook. Reading, MA: Addison-Wesley, 2000. - Friedman, M. "RAID Keeps Going and Going and . . ." IEEE Spectrum, April 1996. - Mee, C., and Daniel, E. eds. Magnetic Recording Technology. New York: McGraw-Hill, 1996 - Mee, C., and Daniel, E. eds. Magnetic Storage Handbook. New York: McGraw-Hill, 1996. NG98 Ng, S. "Advances in Disk Technology: Performance Issues." Computer, May 1989. - Pai, V.; Druschel, P.; and Zwaenepoel, W. "IO-Lite: A Unified I/O Buffering and Caching System." ACM Transactions on Computer Systems, February 2000. - Rosch, W. The Winn L. Rosch Hardware Bible. Indianapolis, IN: Que Publishing, 2003. - Schwaderer, W., and Wilson, A. Understanding I/O Subsystems. Milpitas, CA: Adaptec Press, 1996. - Seltzer, M.; Chen, P.; and Ousterhout, J. "Disk Scheduling Revisited." Proceedings, USENIX Winter Technical Conference, January 1990. - Stallings, W. Computer Organization and Architecture, 7th ed. Upper Saddle River, NJ: Prentice Hall, 2006. - Wiederhold, G. File Organization for Database Design. New York: McGraw-Hill, 1987. - Worthington, B.; Ganger, G.; and Patt, Y. "Scheduling Algorithms for Modern Disk Drives." ACM SiGMETRICS, May 1994.
Session 56	**Exercise:**	
Session 57	**Exercise:**	
Session 58	**Lecture:** File Management – I • Overview - File and File systems - File Structure - File Management Systems	(Chapter 12)
Session 59	**Lecture:** File Management – II • File Organization and Access - The Pile - The Sequential File - The Indexed Sequential File - The Indexed File - The Direct or Hashed File	(Chapter 12)
Session 60	**Lecture:** File Management – III • File Dicrtories - Contents - Structure - Naming • File Sharing - Access Rights - Simultaneous Access	(Chapter 12)
Session 61	**Lecture:** File Management – IV • Record Blocking • Secondary Storage Management - File Allocation - Free Space Management - Volumes - Reliability	(Chapter 12)

Session 62	**Lecture:** File Management – V (Chapter 12) • File System Security • UNIX File Management - Inodes - File Allocation - Directories - Volume Structure - Traditional UNIX File Access Control - Access Control Lists in UNIX
Session 63-64	**Final Exams**

* Stallings, William: Operating Systems: Internals and Design Principles, 6th Ed. 2009. This book has been used as the main reference for compiling this syllabus.

D
Appendix D

A Sample of the Questionnaire

In Pursuit of Process Improvement

This questionnaire is designed to collect opinion of Computer Science lecturers as well as organizational staff members on a process improvement initiative as well as parts that require improvement. The overall improvement of the faculty in both educational and managerial parts will lead the faculty to offer better IT Education to current and future students who are willing to pursue their educational carrier in computer science in Afghan universities.

Your contribution will help me understand the situation better and to derive a model that could help with the improvement of the situation. Please take a moment and go through the following questions and let me know what you think about the situation in your faculty.

Your Personal information will be kept secret and your answers will be dealt anonymously. Thank you very much for taking your time and participating in this survey.

Note: A process is an action taken to execute and complete a task. Relevant and identical processes are put together under a Process Area. For example, teaching one session of a subject in the classroom is considered a process, where preparing for the lecture, developing syllabus, planning the schedule and preparing the requirements for conducting that lecture is considered a process area.

* Required

1. Email address *

2. 2. Name (Optional)

3. 3. Gender *

Mark only one oval.

- ◯ Female
- ◯ Male

4. 4. Your Home University *

Please write name of the university you are employed at its Computer Science Faculty!

5. 5. What is your role at your respective Faculty. (More than one can apply) *

Check all that apply.

- [ ] Lecturer
- [ ] Department Officer
- [ ] Deputy Dean
- [ ] Dean
- [ ] Administrative Employee

6. 6. How long have you been working in your respective Faculty? *

7. 7. Would you like to take part in a recorded interview to discuss the issues related to this survey further more? *

Mark only one oval.

- ( ) Yes
- ( ) No

8. 8. If you agree to a recorded interview, would like to stay anonymous or would you like to be quoted openly? *

Mark only one oval.

- ( ) I give my consent to be qouted directly
- ( ) I'd rather stay anonymous

Part 2 of 7

9. 9. Requirements are material, resources and tools that help with running a process or set of processes in an educational institution. For example, physical space for teaching and administrative activities, library and its related resources, PC-Pools, human resources, office stationary are just some examples that a faculty requires in order to run its processes. What other requirements do you suggest that needs to be considered? *

10. 10. Every faculty in general and every semester in particular have their own requirements. The general and particular requirements needs to be managed systematically to meet the faculty needs. Please explain your opinion!. *

11. 11. A requirement management system in use could help resource planning and resource acquirement during a semester planning and semester execution. Would you agree? *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ I don't know

12. 12. Does your respective faculty have such a system where requirements are handled? If yes, please describe the system.

13. 13. What is your approach to developing requirements of your faculty/department? How do you handle requirements development? *

14. 14. Who is responsible for requirements development in your faculty/department? *

Part 3 of 7

15. 15. Does your Faculty/Department update contents of Syllabi regularly? If yes, how often? *

In Pursuit of Process Improvement

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* Required

1. Email address *

2. 2. Name (Optional)

3. 3. Gender *

Mark only one oval.

- Female
- Male

20. 20. Do you find it necessary to control implementation of syllabi contents during a semester? *

Mark only one oval.

- Yes
- No
- I don't know

21. 21. Would you agree with implementation and establishment of a Syllabi Management system, a system that integrate changes and keeps track of implementation in your faculty/department? *

Mark only one oval.

- Agree
- Disagree
- Neutral

Part 4 of 7

22. 22. Like a project, every semester needs a lot of planning and understanding. There are short term and long term goals to be achieved and tasks to be carried out during a semester, wither organizational tasks i.e. hiring a lecturer, or academic tasks, i.e. taking exams. How do you plan the semester activities within the faculty/department? *

23. 23. What standards and tools do you use to plan the semester? *

24. 24. Do you consider Planning a Semester a necessary activity? *

Mark only one oval.

- Yes
- No
- I don't know

25. 25. Is there a fixed regulation or guideline to planning semester activities within the faculty/department?

Mark only one oval.

- Yes
- No
- I don't know

26. 26. Is everyone committed to the plan? (Commitment to the plan means complying with the plan and making sure everything is executed at its best possible manner according to the plan) *

Mark only one oval.

- Yes
- No
- I don't know

27. 27. How do you get everyone's commitment to execute the plan accordingly?

28. 28. Would you agree to establishing a fixed Semester Planning mechanism through which you could plan all activities of the semester? *

Mark only one oval.

- Yes
- No
- I don't know

29. 29. Do you agree to establishment of a controlling and monitoring process where semester plan and activities are being constantly monitored through out the semester? *

Mark only one oval.

- Yes
- No
- I don't know

30. 30. Would you agree that semester planning, together with a Monitoring and Control mechanism that would check planed activities progress could help the faculty organizers improve quality of service in a Faculty? *

Mark only one oval.

- Agree
- Disagree
- Neutral

Part 5 of 7

31. 31. How do you define Process Quality Assurance within your faculty/department? *

32. 32. What would quality assurance provide your faculty/department with means of improvement? *

33. 33. Does your faculty/department undergo quality assurance checks every semester? *

Mark only one oval.

- Yes
- No
- I don't know

34. 34. Do you think your colleagues would use the quality assurance findings to improve themselves? *

Mark only one oval.

- Yes
- No
- I don't know

Part 6 of 7

35. 35. Are you satisfied with the current way processes are handled in your faculty? *

Mark only one oval.

- Yes
- No
- I don't know

36. 36. Do you think your faculty needs to improve its process and process areas? *

Mark only one oval.

- Yes
- No
- I don't know

37. 37. Please give an example of one or two processes that you think is very important to be improved? Provide a short explanation of how you would improve it. (Feel free to write as many as you want)

38. 38. Do you have access to all laws, regulations and guidelines that are provided by the Ministry and University to your Faculty/Department? *

Mark only one oval.

- Yes
- No
- I don't know

39. 39. Is the laws, guidelines and regulations stored in an easy accessible form so anyone in your faculty could access and use them? *

Mark only one oval.

- Yes
- No
- I don't know

40. 40. Do you think is it possible to improve the current processes in both organizational and educational section of the faculty/department? *

Mark only one oval.

- Yes
- No
- I don't know

41. 41. Do you feel you need to learn more about the execution of certain processes within the faculty? *

Mark only one oval.

- Yes
- No
- I don't know

42. 42. What processes or process areas do you think needs to be worked on and improved? (You may name as many processes or process areas as you want.) *

Part 7 of 7

43. 43. Organizational training is necessary for every employee who gets appointed in an organization. Please name all the training you would wanted to have received when you were appointed in the faculty/department? *

44. 44. Does your faculty/department provide you on the job training? *

Mark only one oval.

- Yes
- No
- I don't know

45. 45. You, as someone who has been working in this faculty for X years, what further training would you like to receive? (X is the number of years you have stated in Question 6. Training can be short term training in certain issues you suggest or long term Master and PhD programs write as many training as you find them necessary) *

This thesis was typeset using LaTeX, originally developed by Leslie Lamport and based on Donald Knuth's TeX. The body text is set in 11 point Egenolff-Berner Garamond, a revival of Claude Garamont's humanist typeface. The above illustration, *Science Experiment 02*, was created by Ben Schlitter and released under CC BY-NC-ND 3.0. A template that can be used to format a PhD dissertation with this look & feel has been released under the permissive AGPL license, and can be found online at github.com/suchow/Dissertate or from its lead author, Jordan Suchow, at suchow@post.harvard.edu.