SERVICE ORIENTED INFORMATION SYSTEMS DEVELOPMENT

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Abstract

One can find the long standing problems with conceptual modeling such as model transformation, reusability and agility in the classical information system development (ISD). New approaches may help in overcoming these issues in conventional ISD's problems. The service oriented approach which is one of the promising approaches, brings solutions to some existing problems. By adopting service orientation in ISD – which we call service oriented ISD, one can deal with the aforementioned problems. This study examines the very notion of service in the context of conceptual modeling method. In particular, we show how to support service modeling in terms of guidance (that is, the way of modeling). The proposed modeling support is demarcated along with a method at the foundational level. We further discuss viability of the proposed method and demonstrate with a real-life case.

Özet

Geleneksel bilgi sistemi geliştirmede model dönüşümü, tekrar kullanılabilirlik ve çeviklik gibi kavramsal modelleme ile ilgili köklü problemler bulunabilir. Yeni yaklaşımlar geleneksel bilgi sistemi geliştirme problemlerindeki bu konuların üstesinden gelmeye yardımcı olabilir. Önemli yaklaşımlardan biri olan hizmete dayalı yaklaşım, var olan bazı problemlere çözümler getirir. Geleneksel bilgi sistemi geliştirmede hizmete dayalı yaklaşım benimsendiğinde söz konusu sorunlar ile başa çıkılabilir. Buna hizmete dayalı bilgi sistemi geliştirme adını vermekteyiz. Bu çalışma da hizmet kavramı kavramsal modelleme yöntemi bağlamında incelenmiştir. Biz özellikle yöntem açısından hizmet modellemenin nasıl destekleneceğini gösterdik. Temel düzeyde, önerilen modelleme desteğinin sınırları bir yöntem ile çizilmiştir. Biz önerilen yöntemin kullanılabilirliğini tartıştık ve gerçek bir olay ile gösterdik.

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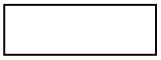
List of Symbols

Ø	Empty Set
+	There are both of them concept and its definition
---	There is no concept and its definition
O	There is the concept but there is no definition about concept
M	Model
L	Language
D	Domain
li	Stakeholder's Interpretation
	Actor
	Action
	Operation

List of Abbreviations

BAD	Business Area Definition
BRM	Business Reference Model
CIAM	Comprehensive Index Assessment Method
CM	Conceptual Model
COSMO	Conceptual Service Modeling
DRM	Data Reference Model
EER	Enhanced Entity Relationship
ER	Entity Relationship
FEA	Federal Enterprise Architecture
IS	Information Systems
ISAC	Information Systems Work and Analysis of Changes
ISAD	Information System Analysis Design
ISD	Information System Development
ISO	International Organization for Standardization
IT	Information Technology
JSD	Jackson System Development
MD	Medical Doctor
NIAM	Nijssen's Information Analysis Methodology
OASIS	Advancing Open Standards for the Information Society
OO	Object Oriented
ORM	Object-role Modeling

OSAD	Object System Analysis Design
OSI	Open Systems Interconnection
PEOU	Perceived Ease of Understanding
PRM	Performance Reference Model
PSQ	Perceived Semantic Quality
PU	Perceived Usefulness
QoS	Quality of Services
SeCSE	Service Centric System Engineering
SOA	Service Oriented Architecture
SOCMM	Service Oriented Conceptual Modeling Method
SOIS	Service Oriented Information System
SOISD	Service Oriented Information System Development
SQ	Syntactic Quality
SRM	Service Reference Model
TRM	Technical Reference Model
UML	Unified Modeling Language
UoD	Universe of Discourse
US	User Satisfaction

Chapter 1

Introduction

Information systems support business functions and processes within or across organizations. This support aspect can be associated with bringing efficiency into organizations [1] [2]. An information system can include fully automated IS, which is often called computerized or system and/or human-based IS.

The way information system is built referred as Information system development (ISD) which is considered as a change process with respect to object systems in a set of environments. Given the nature of ISD that is a complex process which embodies activities performed by different roles (analyst, programmers, clients, project managers), artifacts (models, programs, any documents needed) and needs to be supported by methods, techniques and tools [3][4]. An essential aspect of ISD is modeling, which underpins how informal representation (business needs, requirements) turn into formal or executable artifacts like programs. If modeling (which is related with activities at early stages of ISD) is related to conceptual elements, we call it conceptual modeling. In the literature, one can find various conceptual modeling methods, techniques, and tools.

Conceptual model is an essential component for information systems (IS) development since it shows the process of formally documenting a problem domain for the purpose of understanding and communication among stakeholders [5]. Some well-known examples of conceptual modeling methods involve EER, ER and Use Cases [6]. Conceptual models are used to define user requirements and a basis for developing information systems to meet these requirements. More generally, they may be used to support the development, adaptation, standardization and integration of information systems [5].

To better understand the nature of ISD, scholars characterize ISD in terms of levels of abstraction. ISD is usually characterized in terms of logical and conceptual levels to realize transition from informal representation (e.g. requirement identification and specification) to formal one (e.g. executable models such as programs). These levels are called levels of abstraction. For instance, Iivari suggests that ISD can be represented by three complementary levels: (1) the organizational level, (2) the conceptual-infological level and (3) the datalogical-technical level [7]. Each level requires appropriate conceptual modeling methods and techniques such as NIAM, ISAC, JSD and CIAM [7].

Despite considerable attempts have been made in conceptual modeling, scholars have raised issues such as reusability, agility and model transformation, which we shall discuss them briefly. Model transformation between levels of abstraction is more complicated and problematic issue [7]. There is no exact solution to good model transformation. One of the aims of ISD is that the informal representation in the reality must be used effectively, so informal representation should be transformed formal one with conceptual modeling. Model transformation problem is related to information and models passing among levels of abstraction. Reusability is that conventional methods could be domain specific, so the outputs of the domain specific conventional methods cannot be used in information systems that are in different domains. If the conceptual modeling method is not domain specific, then outputs of conceptual modeling methods cannot be changed dynamically to be compatible with different domains. In the context of ISD, agility has been seen as the ability of "information systems development and deployment methods to swiftly adapt to the changing business requirements" [8]. When business requirements turn into a model like class diagrams then the model transformation problem appears. Transition between business requirements and class diagrams is hard to define clearly in the ISD. This is the example of conventional CM methods' problems.

Several approaches have been proposed to solve problems with conventional methods. One of premises of service oriented approach is that it brings solutions to some existing problems. Service oriented approach's core principles are effective model transformation among levels of abstraction, agility, reusability and communication between business and IT personnel [9]. This orientation can be

adopted in the context of IS development, which is then called service oriented information system (SOIS).

Levels of abstraction change in SOIS, if the service orientation approach is adopted as a solution of conventional methods' problems. In this case we need to consider an additional level of abstraction between the conceptual-infological level and the datalogical-technical level. If the service level is added to levels of abstraction, this level should have some conceptual modeling methods like the other levels. In the literature there have been service conceptual modeling methods related to the service level such as OASIS, SeCSE, COSMO.

SOIS may benefit from other endeavors focusing on service oriented architecture (SOA) point of view, web services development. Given the importance of conceptual models to analysis and design of IS, our focus in this work is to adopt service orientation in the context of conceptual modeling. In particular, we propose a service-oriented conceptual modeling method to support modeling activities at the service level.

This study facilitates understanding of service orientation at the service level, elicits a new service conceptual modeling method and illustrates the proposed conceptual modeling method via cases. The cases are about healthcare IS and student registration IS at a university.

1.1 Research Approach & Methods

In this section we will describe how the study has been carried out. This part includes the stages of our study and the methods that have been used. The deliverables of this study are as follows; proposing conceptual modeling quality measurement items in service context, proposing a service oriented conceptual modeling method, demonstrating the proposed new service oriented conceptual modeling method via a healthcare information system and validating the proposed conceptual modeling method to check viability via a student registration information system.

While exploring the service oriented approach to IS development from the conceptual modeling perspective, the following key research questions need to be answered.

- How service orientation is understood in the context of conceptual modeling?
- What are the quality principles of conceptual models?
- What are the characteristics of conceptual models related to service level of SOIS?
- What would be a generic or an appropriate conceptual modeling method in a service context?
- How to apply the proposed model in an actual project? What are the results of practical evaluation of presented conceptual model for a case?

In the first chapter we introduced some definitions about information systems, its development (ISD) and service orientation. The structure of the study is as follows: the second chapter includes literature review for this study. In the literature review we will give some fundamental information about research issues from literature. The focus of this section includes service concept, conceptual modeling and levels of abstraction. The third chapter includes details of the conceptual model that we proposed. It includes a guidance to create appropriate services about the relevant domains. In the fourth chapter a demonstration can be found for the proposed conceptual modeling method via healthcare information system. The fourth chapter includes also a validation about the proposed conceptual modeling method via student registration information system to check viability. The last chapter of the study is a conclusion chapter.

We show how the research has been carried out in terms of key activities in Figure 1.1. One can see that overall the research method is iterative in nature and subject to some demarcations for exploring the boundary of the research problem. This means that the research approach has more explorative rather than design science characteristics.

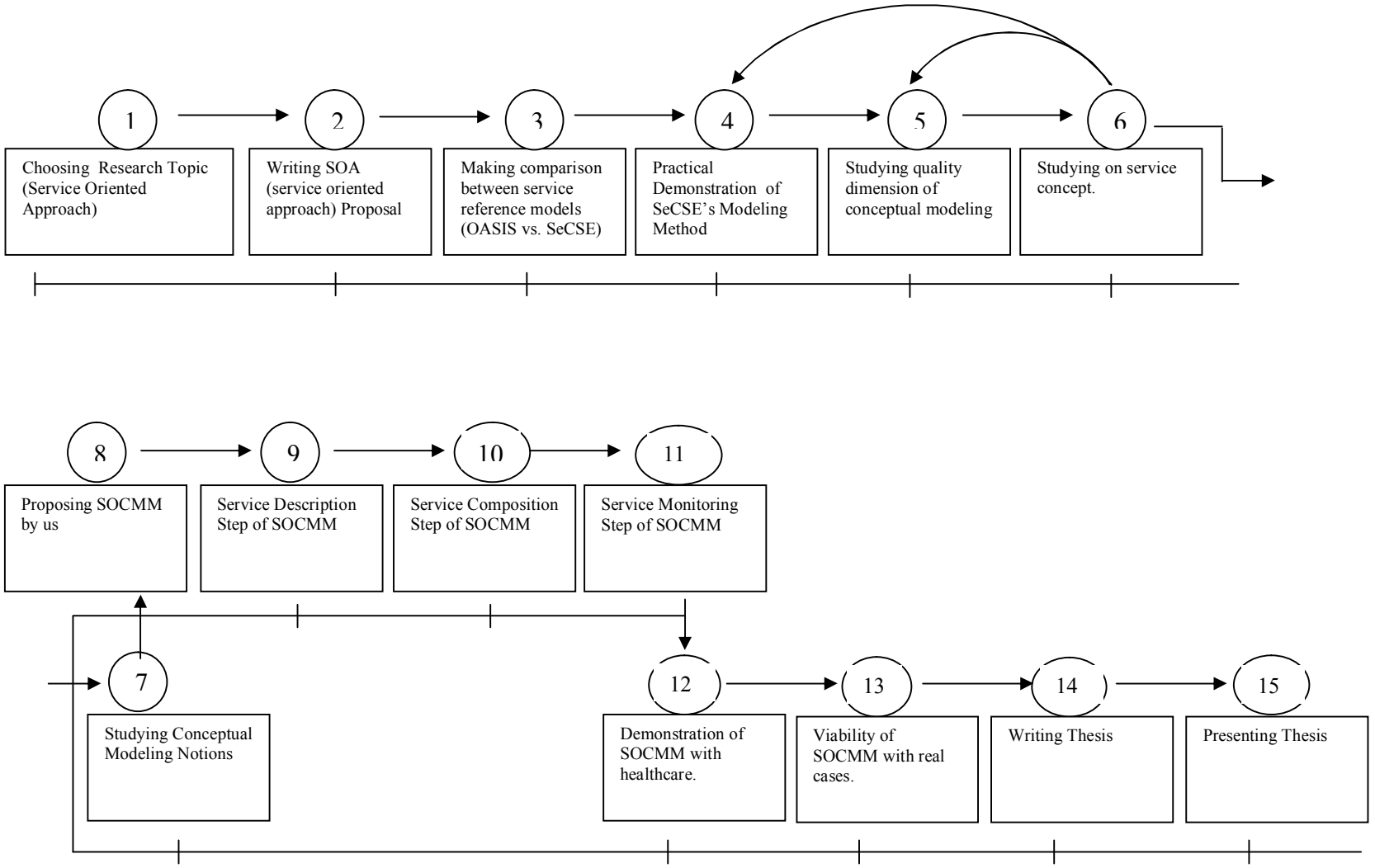


Figure 1.1 Research activities

Chapter 2

Literature Review

This study is tightly coupled with three core subject matters, which are levels of abstraction, conceptual modeling and service orientation. In this study, service orientation is examined with conceptual modeling concepts at the service level.

2.1 Levels of Abstraction

For typical IS development, one can take into account different levels of abstraction [7]. As mentioned before in ISD there have been three major levels of abstraction which are (1) the organizational level, (2) the conceptual-infological level and (3) the datalogical-technical level [7]. Levels of abstraction refer to a hierarchical concept structure with four characteristics: 1) the hierarchical relation is linear, 2) the levels describe different characteristics of the same object system, 3) the upper levels include in some sense a more abstract description of the object system than the lower levels, and 4) the concept structure includes a definition of the relationships between the levels [7]. Figure 2.1 illustrates the hierarchical structure of levels of abstraction. Each level has its own modeling concepts, principles and conceptual modeling methods [7]. Conceptual modeling activities rest on higher level of abstraction. Number of levels and labeling these levels depend on an underlying logic or framework associated with the method adopted.

One can consider several modeling aspects of information systems such as process, information, behavior, organization and problem [10]. Each aspect needs to be analyzed and designed along with the conceptual models but the challenge is how to achieve transitions between aspects of the information systems. There are no truly and good representations which cover all aspects of information systems. Every aspect does not deserve the same attention at each level [10]. Although each aspect

has good modeling technique(s) in ISD such as ER, model transformation is required among aspects; because there must be a relationship among models of IS aspects. According to Slooten (1996) in classical way to analyze an information system, there are two main levels of abstraction in IS (ISAD and OSAD Level) [10]. The levels of abstraction in Iivari can be accepted for ISD levels as vertically and the aspects of ISD in Slooten can be accepted as horizontally. Table 2.1 shows classical ISD structure.

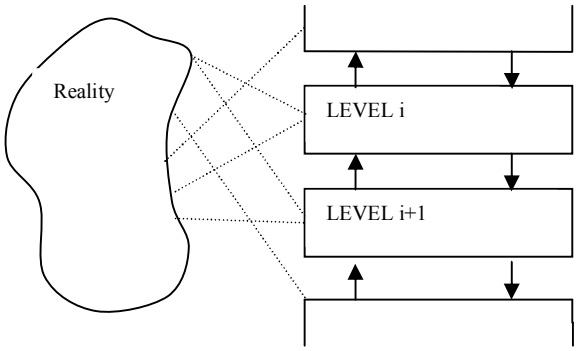


Figure 2.1 Hierarchical structure of levels of abstraction.(Depicted from [7])

The conceptual modeling methods which are in different levels of ISD use information in the reality as shown in Figure 2.1. When informal representation (e.g. requirement identification and specification) which is in reality turns into formal one (e.g. executable models such as programs), the conventional conceptual modeling methods have agility, reusability and model transformation problems. As mentioned before to solve these problems the new approaches are needed, so one of the promising approaches is service oriented approach. The idea is that service oriented approach can help in solving problems with agility, reusability and model transformation. The agility problem is solved by following way. The services and services' properties can be changed an agile manner in service oriented information system. To solve reusability problem, created services should be used in different information systems in different domains. The created services can be setup a good communication to model transformation between the upper level and the lower level.
For the service oriented information system development, the new level of abstraction which is named service level, is added to the classical IS levels of abstraction. There have been several representations about the service oriented

information system in the literature [Microsoft's representation for SOIS, SOMA representation from IBM and FEA framework].

Table 2.1 Aspects of IS and levels of abstraction of IS. [7][10]

<table>
<tr><th></th><th>Process</th><th>Information</th><th>Behavior</th><th>Organization</th><th>Problem</th></tr>
<tr><td>Organizational Level</td><td>Conceptual Model 1</td><td colspan="3">Conceptual Model 2</td><td></td></tr>
<tr><td>Conceptual / Infological Level</td><td colspan="5">Conceptual Model 3</td></tr>
<tr><td>Datalogical / Technical Level</td><td>Conceptual Model 4</td><td>Conceptual Model 5</td><td colspan="3">Conceptual Model 6</td></tr>
</table>

As a matter of the study context, we consider Federal Enterprise Architecture (FEA) as a suitable framework, which provides us with a multi-level architectural pattern [11]. This pattern starts with top-down with non-functional requirements at the Performance Reference Model level (PRM), business processes at the Business Reference Model level (BRM), and logical components at the Service Reference Model level (SRM), on downward [12] (Table 2.2).

Another reason to choose this framework is that it is easy to relate business and technical perspectives in a coherent way and has more meaningful levels than the others. In the FEA there are five levels and given the study focus, we look at the Service Reference Model (SRM) level. This level appears to be a common and mediating level in other frameworks as well. In general, this level can be associated and explicated with some reference models.

Service level has its own conceptual modeling methods (e.g. OASIS, SeCSE, COSMO) like the other levels in IS to analyze and design the relevant level of abstraction in the service oriented information system.

Table 2.2 Adopted from Federal Enterprise Architecture (FEA) framework

PERFORMANCE REFERENCE MODEL(PRM) Inputs, outputs and outcomes Uniquely tailored performance indicators
BUSINESS REFERENCE MODEL (BRM) Lines of Business (Functions and sub-functions) Agencies, customers, partners
SERVICE REFERENCE MODEL(SRM) Service domains, service types Business and service components
DATA REFERENCE MODEL (DRM) Business-focused data standardization Cross-agency information exchanges
TECHNICAL REFERENCE MODEL (TRM) Service component interfaces, interoperability Technologies, recommendations

2.2 Conceptual Modeling

In the context of SOIS Development, a conceptual model describes actors, activities and entities involved in a service-oriented scenario and the relationships between them. One of the principles of developing a conceptual model is to achieve a good fit between its instantiation and possible service-oriented scenario [13].

Conceptual modeling comprises four elements which are shown in Figure 2.2. The four elements are conceptual modeling context, conceptual modeling method, conceptual modeling grammar and conceptual modeling script respectively. The conceptual modeling context represents the conceptual model domain (e.g. database, service orientation, analysis and design) [14]. The conceptual modeling methods provide some procedures and processes to identify instances of all phenomena that can be modeled via a grammar [14]. The conceptual modeling method is called conceptual modeling guidance by Moody [5]. The conceptual modeling grammar is a language. The language includes some notations and structures about relevant concepts to create the conceptual modeling scripts which can be graphics and maps about relevant conceptual modeling methods [14]. According to Brinkkemper *et al*.

(2001) conceptual models consist of product and process aspects [15]. The process aspect refers to the conceptual modeling method in Wand and Webber, (2002) [16] and refers to the model guidance in Moody, (2005) [5]. The product aspect refers to the conceptual modeling scripts in Wand and Webber, (2002) [16]. Conceptual models, either implicit or explicit, should act to guide process of information exchange [17].

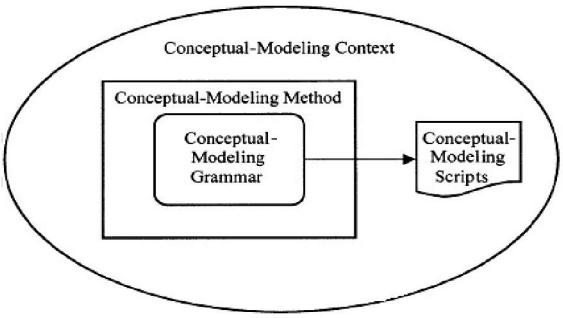


Figure 2.2 Conceptual modeling [adopted from 16]

There is an additional dimension which is the quality dimension, for the conceptual modeling. The proposed conceptual modeling methods should be evaluated from quality point of view to check appropriateness of the conceptual modeling methods. This evaluation needs some quality criteria. When we look at the conceptual modeling literature we can find several studies about the quality of conceptual modeling methods. If the quality of conceptual modeling methods can be measured, the conceptual modeling scripts could be qualified. We will give quality metrics to evaluate the conceptual modeling methods in rest of this study.

2.2.1 Quality Element of the Conceptual Modeling

Evaluation of Conceptual Models is the key issue in IS. As mentioned before conceptual modeling has five basic elements which are conceptual modeling context, conceptual modeling method, conceptual modeling language, conceptual modeling scripts and the quality of conceptual model. This section of the study mainly focuses on quality perspective of conceptual modeling. There have been many researches about the quality criteria based on evaluation of conceptual models but the quality

perspective of conceptual modeling have not been studied in service context. Quality criteria in service context are proposed to measure the quality of conceptual models in this section of study.

There are two powerful conceptual model quality frameworks. The first one is Lindland's framework that is based on "semiotic and theoretical framework", the other one is Moody's "practical based framework" which consists ER and data models. Linland's framework has four cornerstones (components) such as model, language, domain and audience interpretations [18]. The model is the set of statements which is represented by Moody *et al*. 2003 [19]. The language consists of all possible set of statements according to the grammar of the language [19]. The domain is the set of statements that would be correct and relevant to make about the problem domain (called universe of discourse UoD) [19]. The audience interpretation is what the audience of relevant stakeholders think is expressed in the model [19]. The model quality is defined by relationships between the model and other framework cornerstones. These relationships use three semiotic levels Syntactic, Semantic and Pragmatic Quality [18]. Syntactic Quality relates the model to its language, Semantic Quality relates the model to its domain and Pragmatic Quality relates the model to its audience interpretations [20] as shown in Figure 2.3.

The most proposed frameworks about CM quality are based one of the conceptual models such as ER, EER, Data models, ORM models etc. [5]. In 2003 Moody has been realized empirical validation of Lindland's quality framework for any kind of conceptual models not just one special model (e.g. data models, process models, interaction models) [19]. Lindland's framework has been become more powerful after this validation, so we can call Lindland's framework as theoretical and practical based framework.

There are definitions about quality categories that are proposed in the validation work of Moody. Quality categories are Syntactic, Semantic and Pragmatic Quality [18]. Each category differentiates between quality goals and means [18].

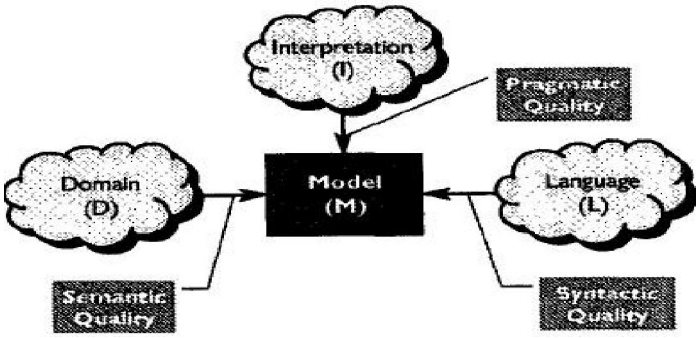


Figure 2.3 Adopted from Lindland Quality Framework [18]

In 2007 Krogstie has been extended Lindland's framework and has added the Domain Knowledge as a cornerstone (element) to the framework. The relation between domain knowledge and user interpretations is called perceived semantic quality as the fourth semiotic level of conceptual model which is also shown in Figure 2.4. Domain knowledge is the information on which users think about what the script contains should be, based on users' knowledge of the problem domain [21]. Perceived semantic quality is generated from the definition of semantic quality.

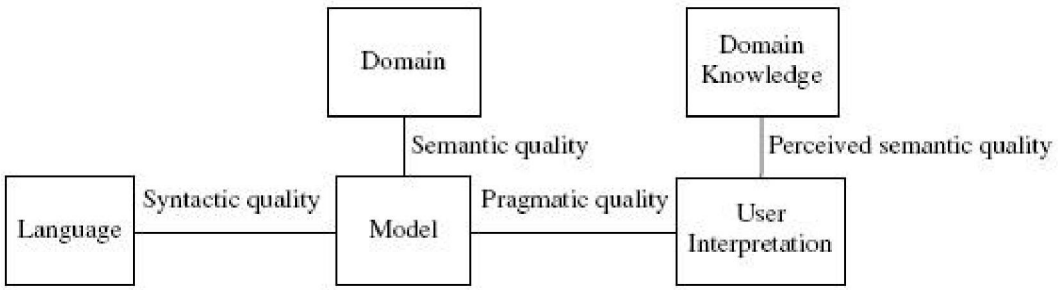


Figure 2.4 Krogstie *et al*'s [24] extended framework for quality of conceptual modeling scripts

According to Maes *et al.* the semantic quality is difficult to evaluate (and perhaps even impossible) reality [21]. Perceived Semantic Quality should be easier to measure than semantic quality. After this evolution of quality framework, Maes said that the quality of CM can be measured only with the user point of view meaningfully, so in Maes *et al*. a framework is proposed which is about the quality of CM from the user point of view that is shown in Figure 2.5. According to Maes *et al*. there are four constructs to evaluate conceptual models from user point of view such that perceived semantic quality (PSQ), perceived ease of use (PEOU),

perceived usefulness (PU) and user satisfaction (US). Maes' framework is generated from IS success model.

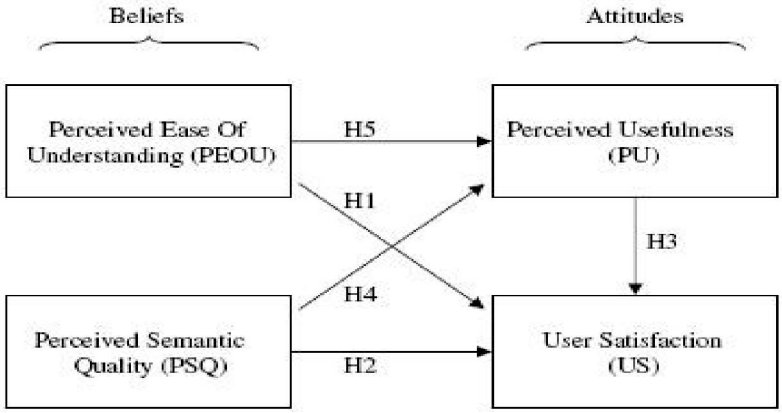


Figure 2.5 User evaluation based quality model for conceptual modeling scripts [21]

In this point we have three quality criteria to evaluate CM, so we should evaluate the CM with these quality criteria that includes syntactic quality, user evaluation based quality constructs and pragmatic quality.

Pragmatic quality is out of our scope because pragmatic quality is the most abstract semiotic level than the others, so the comprehension of the pragmatic quality is so difficult.

2.2.2 Quality Criteria Evaluation

2.2.2.1 Syntactic Quality

Syntactic quality is a relationship between the model and its language (grammar). The syntactic quality of model and grammar quality have different meanings. But the grammar quality influences the conceptual model syntactic quality. The grammar quality can be express by five components such that accuracy, syntactic completeness, conflict-free, no redundancy and expressiveness [22] [23].Full details of the grammar quality can be found in [22] [23]. The goal of syntactic quality is syntactic correctness which can be defined as this notation: M\L=ø [19]. The notation means that all statements in the model are based on the syntax and

vocabulary of the modeling language [24]. Model is represented by M and language is represented by L.

2.2.2.2 User Evaluation Based Quality Constructs

Perceived Semantic Quality (PSQ): The perceived semantic quality is closely related to semantic quality, so it is generated from definition of the semantic quality. The perceived semantic quality can be defined as the relation between user interpretations and domain knowledge. Goals of the perceived semantic quality are *Perceived Validity* and *Perceived Completeness* as the same with the semantic quality [24]. In the perceived semantic quality users will perceive the semantic quality (semantic quality is understood by users point of views) of the script as how valid and complete it with respect to their perception of the problem domain [21]. Validity can be defined as this notation M\D=ø. The notation means that all statements in the model are correct and relevant to the problem [24]. Domain is represented by D. Completeness can be defined as this notation D\M=ø. The notation can be read as the model contains all statements that would be correct [24].

Perceived ease of understanding (PEOU): The degree of user believes that using a conceptual modeling script for understanding the problem domain and IS requirements would be free of mental effort [21].

Perceived Usefulness (PU): User will make judgments about how effective the script is in expressing and communicating their view of the domain and IS requirements after interacting with the conceptual modeling script (adapted from [21]). Actually in perceived usefulness users evaluate the usability of the script from their point of view.

User Satisfaction (US): US is a general evaluation of the quality of conceptual modeling script from user's point of view. This evaluation can be measured in terms of how satisfied users are with the script with respect to its purpose [21].

2.2.2.3 Pragmatic Quality

Pragmatic quality is a relationship between the model and its audience's interpretation. The goal of this quality is comprehension for each stakeholder. Comprehension can be defined as these notations M\Ii=ø and Ii\M=ø. The notations mean that the model does not include the statements that are not in the stakeholder's interpretation of the model. Stakeholder's interpretation is represented by Ii [19].

Table 2.3 Summary of quality criteria based evaluation

TYPE	Quality Categories	GOALS	NOTATION
Lindland's Framework	Syntactic Quality	Syntactic Correctness	M\L=ø
Maes Framework User Evaluation Based Quality Constructs Generated From Krogstie's Framework	Perceived Semantic Quality	Validity and Completeness	M\D=ø
	Perceived Ease of Understanding		
	Perceived Usefulness		D\M=ø
	User Satisfaction		
Lindland's Framework	Pragmatic Quality	Comprehension	M\Ii=ø & Ii\M=ø

2.2.3 Measurement Items

There are proposed items that are shown in Table 2.5 to measure the quality of conceptual models from user's point of view [21]. The items should be answered that choosing one of 5-point Likert scale from 'strongly disagree' to 'strongly agree'. The PEOU items were proposed by Gemino and Wand [22]. PU measures are used from Moody who generated from TAM by Davis. US measure is taken from Seddon and Yip's. The last measure is PSQ which was developed by Poels *et al* [21]. According to our scope we have to know that what the syntactic quality items are. Actually user satisfaction construct include the syntactic quality items. In this point we have decided four syntactic quality items which are shown in Table 2.4.

Table 2.4 Measurement instruments for syntactic quality

SQ1	Semantics of problem domain were completely represented by CM. (Completeness)
SQ2	It did not contain redundant semantics. (No redundancy)
SQ3	The semantics of the problem domain were accurately represented by CM. (Accuracy)
SQ4	The semantics that were represented in different parts of the model, did not contradict one another. (conflict - free)

Table 2.5 (adapted from [27]) Measurement instruments for PEOU, PU, US and PSQ constructs

PEOU1	It was easy for me to understand what the CM was trying to model	PU1	Overall, I think the CM would be an improvement to a textual description of the information system.
PEOU2	Using the CM was often frustrating	PU2	Overall, I found the CM useful for understanding the service level of information system.
PEOU3	Overall, the CM was easy to use	PU3	Overall, I think the CM improves my performance when understanding the service level of information system.
PEOU4	Learning how to read the CM was easy	PSQ1	The CM represents the service level of information system correctly.
US1	The CM adequately met the information needs that I was asked to support.	PSQ2	The CM is a realistic representation of the service level.
US2	The CM was not efficient in providing the information I needed.	PSQ3	The CM contains contradicting elements.
US3	The CM was effective in providing the information I needed.	PSQ4	All the elements in the CM are relevant for the representation of the service level of information system
US4	Overall, I am satisfied with the CM for providing the information I needed.	PSQ5	The CM gives a complete representation of the service level.

5-point Likert Scale includes these items.

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

Category items are that:

PEOU: Perceived ease of understanding.
US: User Satisfaction.
PU: Perceived Usefulness.
PSQ: Perceived Semantic Quality.
SQ: Syntactic Quality.

The gray column of Table 2.5 which includes perceived usefulness (PU) and perceived semantic quality (PSQ) is revised for service context.

There have been various proposed conceptual models for business and technical levels of abstraction in SOIS. In the business level, such models as use case model, flowcharts, activity diagrams which are widely used to determine business requirements, business needs. Technical level has also widely used conceptual models to analyze and design an information system, such as ER, EER [25]. In the service level of abstraction of SOIS, various conceptual models are proposed such as OASIS [26], SeCSE [13], COSMO [14].

When we look at the conceptual models in service context from five dimensions of conceptual modeling perspective: The proposed conceptual models have no sufficient information to understand conceptual modeling methods. Lack of sufficient information is a major reason for misunderstandings about how conceptual modeling scripts are elicited. If the conceptual modeling methods are not articulated explicitly, providing conceptual modeling scripts are not possible. The proposed models lack guidance for modeling services and furthermore underlying concepts are not articulated explicitly at foundational level and one can see obscurity in service modeling. When the proposed conceptual modeling methods are evaluated from quality point of view, some conceptual modeling methods take the lower quality grades.

We assume that if the deficiencies of developed service conceptual models are removed and if the conceptual modeling method or conceptual modeling guidance

comes to service modeling, the problems of conventional conceptual modeling methods may be solved. Conceptual models consist of product and process aspects [15]. In the service level, Conceptual modeling method should undertake a guidance role for process aspect of conceptual model. The conceptual model helps us about eliciting conceptual modeling scripts (products) which are forms and examples for appropriate services to relevant information systems. Until today, mostly published works are about automated services such as web services [27] [28] [29]. In this reason a conceptual model at the service level should involve both kinds of services that are automated which comprise web services and other software services, and non-automated services which comprise human-based services. This study proposes a service conceptual modeling method to analyze service level of SOIS and to develop appropriate services. The proposed conceptual model also involves guidance and facilitates in creating conceptual modeling scripts.

To understand the service conceptual modeling methods we have to understand service notion. When we look at the service literature, various domains (telecommunication, computer science, business, economy) in IS service is defined from different perspectives.

2.3 Service Orientation

The notion of service can be examined in terms of such aspects as interaction, capability, operation, application, feature, behavior and process. If we want to define a service in a broader sense, we need to take into account all relevant service aspects. If we cover relevant aspects of service, we believe that problems with the conventional CM methods can be removed. The service concept is perceived as different meanings in different domains such as telecommunication, economy, business, computer science. We assume that each perceived meaning can be used as a basis for characterizing the service along with aspects. In the following, we shall present how service notion is articulated in various research domains.

Service as interaction: The service is an interaction between service provider and service consumer. In classical analysis of IS first of all, the business area definition deliverable document includes domain scope. After the first step of classical analysis

of IS business requirements are written. Service provider wants to create services to meet business requirements; however service consumer wants to get benefits about the domain in which services are created by service provider. The IBM Services Research Group defines a service as a provider/client interaction that creates and captures value [14]. For instance a medical doctor/patient relationship is an interaction and both of them medical doctor and patient wants to get value (profit) from this relationship. Medical doctor wants to earn money from curing a patient. Patient wants to get health from curing. There is a benefit to each participant in this interaction.

Service as capability: Service is the capability of a service provider to produce some intangible benefits to other services, service consumers etc. [30]. We mentioned above the goal of service is that services should meet the business requirements. Services require an assessment, during which provider and consumer come to understand capabilities and goals each other. In our case we can think that the medical doctor is a service provider role to provide a health service and the patient is a service consumer to consume a health service. The health service is a capability of the medical doctor, so capabilities of medical doctor produce some benefits to its environment and the patient utilizes from this capability.

Service as operation: In object-oriented and component based design, each operation or method is usually seen as a service [14]. A service is a part of the object's behavior, which a client can invoke. In the application or technical level of information system when a project is implemented by a programmer, each method of software acts as a service. In this case programmer is a service provider who provides operations as services. The service consumer is user who invokes methods or operations of implemented project, in this case. In our case if we think curing process, surgery could be operation and of course at the same time it could be a service.

Service as application: In application or technical level of IS, services are implemented as web services. Services in general, are most commonly seen as applications (pieces of software) that can be accessed over the Web. Web service is

a software system designed to support interoperable machine-to-machine interaction over a network [30].

Service as feature: In the telecommunications domain the term service is usually to refer to a feature that can be provided on top of the basic telephony service, such as call forwarding, call back[14]. The standardizations of data communication, which are ISO and OSI, include features of data and data communication such as connection-oriented and connectionless communications. For example in this area each communication type (connection-oriented or connectionless communication) is seen as a service.

Service as observable behavior: A service is traditionally defined as the observable, or external, behavior of a system. For example, define a service as "the behavior of the [service] provider as it can be observed by the users." In other words the service of a system is the set of all possible interactions between the system and its environment and their ordering in time [14].

Service as a process: In marketing and the other disciplines we can see a service as a process. For instance the implementation phase of software has some various processes. In the medical doctor – patient example, curing activity has a group of processes, in classical analysis of an IS use cases have processes. Each process of examples, which are said above, can be seen as a service. We can say that process between service provider and service consumer is a service.

Finally, service is perceived differently in different domains. We assume that our service perception could not be domain specific and we believe that different perceptions of service in different domains only are aspects of service and our service perception should be global. The key problem of IS which is model transformation between levels of IS, can be removed, if we design the service truly. Good designing of service includes each aspect of service. According to service perceptions each process, interaction, behavior, feature, application and operation can be seen as a service in an IS. Just we need to a methodology and guidance for service representation.

2.4 Evaluation Frameworks for Service Conceptual Modeling Methods

This study includes a new service conceptual modeling method, which is named SOCMM (Service Oriented Conceptual Modeling Method). As mentioned before there have been the proposed service conceptual modeling methods such as OASIS, SeCSE and COSMO. To see the differences between our conceptual modeling method (SOCMM) and the others, we should create an evaluation framework. The conceptual modeling elements should be center of an evaluation framework. The first evaluation can be seen in Table 2.6.

Table 2.6 Conceptual modeling methods vs. CM dimensions

CM Elements / CM Methods	CM Context	CM Method (Guidance)	CM Language	CM Scripts	CM Quality
OASIS [26]	Service Context	---	---	---	Measurement is needed
COSMO [14]	Service Context	---	UML	---	Measurement is needed
SeCSE [13]	Service Context	---	UML Profile	---	Measurement is needed
SOCMM	Service Context	+	UML Profile	+	Measurement is needed

(+) Fully articulated.

(---) Not mentioned.

OASIS tries to give a framework about service oriented information system. It includes some definitions for key concepts about service oriented information system. There are no guidance, language and scripts in the OASIS.

COSMO is a conceptual framework for service modeling, but it mentions just about service composition. It gives some figures which are related to service composition and they are represented by UML class diagrams.

SeCSE has a lack of guidance or method and uses UML profile [13]. SeCSE does not give any scripts in the conceptual modeling method. The conceptual modeling methods are needed an evaluation by quality perspective. To measure quality of

conceptual modeling methods quality measurement items are proposed in service context in this study.

SOCMM is in service context, it has a method or guidance to create scripts and it has a validation via student registration information system, which is real case. The SOCMM has also conceptual modeling scripts. The steps of modeling method are implemented by UML profile as a language. The second evaluation framework can be found at the end of Chapter 3.

Chapter 3

Development of New Conceptual Modeling Method (SOCMM)

We introduced classical information system development (ISD) and service oriented information system development (SOISD) in the early sections. Also we mentioned service orientation and conceptual modeling issues. We maintain that one can find various levels of abstraction in ISD and each level of abstraction has its own conceptual model or models. Conventional conceptual models are subject to issues such as model transformation, reusability and agility. To solve the problems with conventional conceptual modeling methods, one should consider alternative approaches. It is our contention that service oriented approach brings solutions to our long standing problems with ISD. In the service oriented approach, service level of abstraction was added to the levels of abstraction in service oriented information system (SOIS).

Although there have been conceptual modeling methods in service context, we introduced that existing conceptual modeling methods have some weaknesses such as lack of guidance. Guidance is an essential aspect of a method for the creation of conceptual modeling scripts. It refers to the conceptual modeling method in Wand and Webber [16]. The conceptual modeling method is one of the key elements of conceptual modeling. Thus, there is a need for a new conceptual modeling method for the service level in SOIS development. The following section of this research includes the new service oriented conceptual modeling method, the name of which is service oriented conceptual modeling method (SOCMM). SOCMM gives guidance to model service level and service creation.

Before proposing a new conceptual modeling method, we need to know the context of conceptual modeling, which is one of the key elements of conceptual modeling.

SOCMM regards the service context and we introduced the notion of service at the research background section of this research. Service is perceived differently in different domains. We believe that different perceptions of service in different domains are valuable to induce aspects of service. The aspects of service which come from the service orientation literature are the underpinnings of SOCMM. The following table summarizes key aspects of the notion of service level. The table includes aspects and its key concepts. The first row includes the service aspects and the second row includes the key concepts.

Table 3.1 Service aspects in service level of abstraction

Service Aspects	Service as interaction	Service as capability	Service as operation	Service as application	Service as feature	Service as observable behavior	Service as process
Key Concepts	Service provider, Service consumer, Value, Benefits	Intangible benefits, Service provider, Environment	Object's behavior, Method	Application level, Web service	Data, data communication	Interaction, system and environment	Activity

The created service as a result of conceptual modeling method should include service aspects' features.

3.1 Conceptual Modeling Method Overview

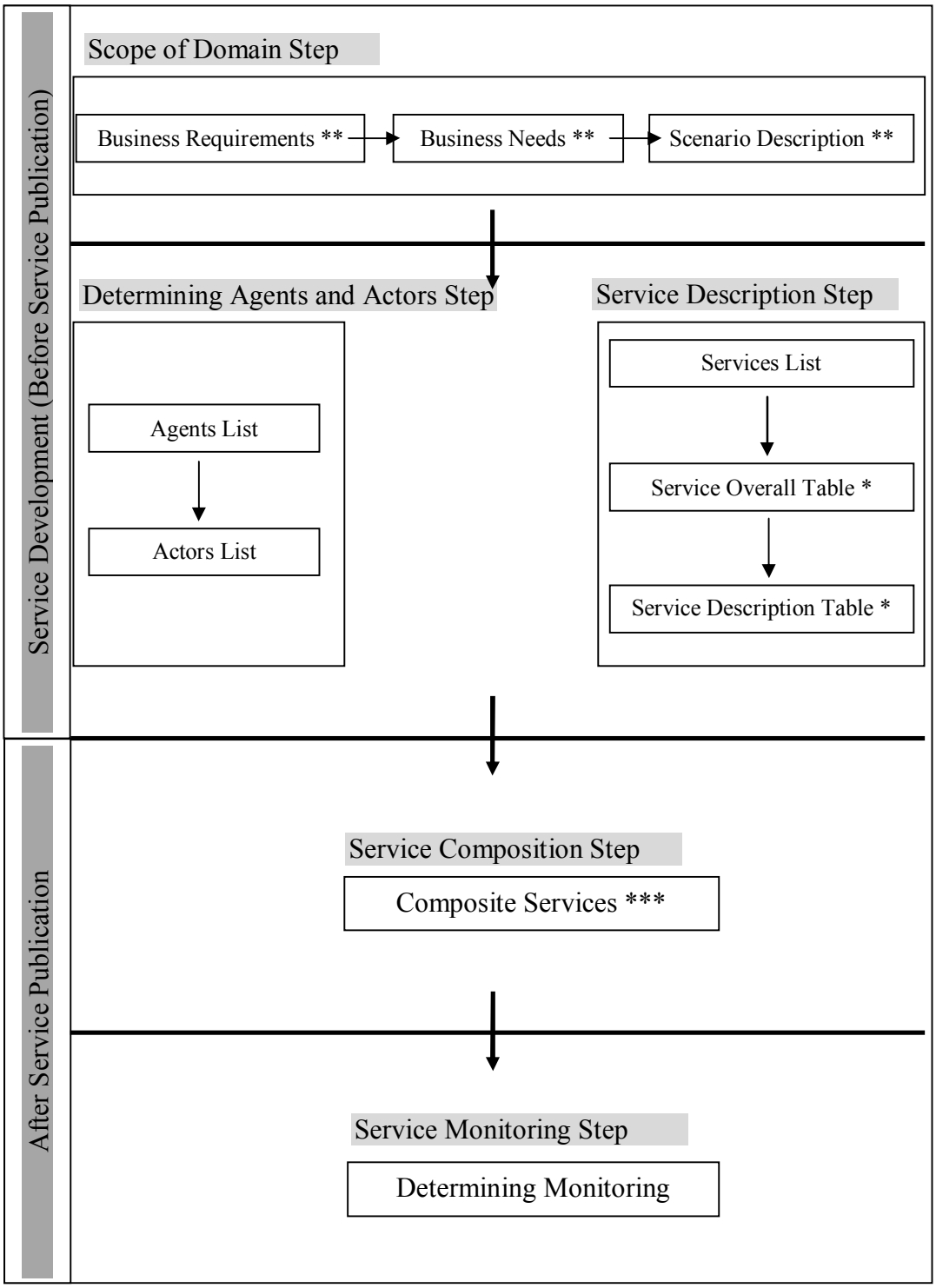
The service level conceptual modeling method (SOCMM) that will be presented in the remaining chapter, aims at providing a common terminology across SOIS's service level. It has been designed as a compact and extensible model that takes into account all the concepts that have been identified as fundamental to SOIS. It also aims to produce a conceptual modeling method or a guideline to conceive appropriate services about a relevant information system. According to Brinkkemper, conceptual modeling has two aspects, which are process and product [15]. We mentioned before that previously proposed conceptual models in service level have lack of guidance. At this point we propose a conceptual modeling method in terms of the process aspect of conceptual modeling and which provides guidance for processes. To guide the processes of conceptual modeling method some steps are identified: (1) Scope of Domain for relevant SOIS (2) Determining Agents and Actors, (2a) Deciding IS Requirements (taken from business level), (3) Service

Description (3a) Determining Service Specifications (3b) Determining Service Additional Information, (4) Service Composition, (5) Service Monitoring. When a step ends, the other step starts in water fall model which has sequential steps. Although SOCMM looks like similar to the water fall model, the second (determining agents and actors) and the third (service description) steps are not sequential. They are occurred simultaneously. Map for creating SOCMM products is shown in Figure 3.1.

3.1.1 Scope of Domain

The first step of our conceptual modeling method is to identify the scope of the domain. Conceptual modeling method needs a deliverable document to understand the requirements of the domain and to give information about the domain for all actors of SOIS. To conceive a model in service level we should accept that upper level's (such as Business level) modeling techniques are proper. Their outputs, which are business requirements, needs, and scope of domain, become inputs to our conceptual modeling method. After identifying deliverable of the scope of domain step and business requirements, Offered Services are identified by the service providers of SOIS.

Services have to have some properties, which are presented in the next section. We can say that each or many business requirements are performed by a single service or multiple services. The analyst or the system engineer of SOIS's domain conceives Offered Services (offered by the analyst and created by the provider) for the relevant domain according to business requirements and scope of the domain deliverable (such as BAD: Business Area Definition document). Actually the scenario of relevant information system plays an important role in examining the services by the system engineer. This step of conceptual modeling method is modeled by the analyst and service provider without service consumer contributions. At the beginning of the conceptual modeling method the system engineer offers services for a relevant information system and the service provider provides Offered Services. Offered Services are stored in a pool, called service pool. All services in the service pool are Offered Services at the beginning of the conceptual modeling method. If service consumers cannot find their requests in the service pool, consumers can advise new service(s) to the service provider, which is called a Requested Service.



* It is needed for each service.

** It comes from Business Level of abstraction.

*** It is created according to service consumer requests.

Product.

Figure 3.1 Map for creating SOCMM products

This consumer–oriented view of service is central to SOIS and differentiates it from object orientation (OO) [31]. In OO, an object represents what it is, but in SOIS a service represents how its consumers wish to use it [31].

All services which are in the service pool, have to cover all the needs and requirements that come from the business level of SOIS. Scope of domain is used to show the relation between needs and requirements, and created services. Also scope of domain is used to check services in the way of service appropriateness which means that service is in scope or is there any needed service which is not created? To demonstrate the importance of the notion of scope, we shall give an example in a healthcare information system. To determine the scope of domain we give a scenario for a relevant information system and we will create services according to this scenario in the next steps. In the scope of domain step a scenario is examined about a relevant information system.

A patient wants to have a treatment about his/her disease. For this reason he/she decides to go to a clinic which is specialized in the area of the disease. First of all he/she calls the clinic to acquire information about the standard procedure for the treatment. He/she wants to talk an employee of the clinic and asks some questions about the rules of procedure for the treatment. After learning about the procedures, the patient starts to carry out the steps of the procedure. The first rule of the procedure is to make a reservation. There are two ways of making a reservation: either by making a phone call or submitting a form on-line over the Internet. If the patient wants to make a reservation by making a phone call he/she has to talk an employee of the clinic to book the medical doctor who is an expert about the disease. After taking the appointment with the medical doctor, the patient is supposed to make a reservation for the examination. If the patient wants to make an on-line reservation over the Internet, he/she has to enter the web site of the clinic and then click on the reservation link, thereafter he/she needs to choose a medical doctor who is one of the experts of clinic's medical doctors about his/her disease. In choosing a medical doctor, the patient is able to select the most convenient time slot from the list of available time slots displayed on the page. When the patient goes to the clinic for the appointment, the medical doctor (MD) calls the patient for an examination. MD meets with the patient and the patient to complete some tests for the

examination of the symptoms in order to be able to identify the disease. The patient is finally diagnosed according to the results of the tests. If the MD has every confidence that the diagnosis of the illness is made successfully, then the procedure for its treatment is started. At this point the MD gives information to the patient about the disease as well as the medication (solution techniques and the method which is followed to solve problem). Some medicines about the disease can be given or the patient may be given an advice for a surgery after these processes. In either case there will be control meetings to keep in checking up the disease.

3.1.2 Determining Agents and Actors

The second step of our conceptual modeling method is to determine the agents and actors of the domain. In the literature there have been two key actors in the service conceptual model: Service Provider and Service Consumer [14] [26] [32]. Service Provider is the entity that makes a service available to use [33]. Service Consumer is the entity that invokes and exploits a service to accomplish some goals [33]. In this point two new notions emerge, which are Offered Service and Requested Service. The user perspective defines the participation of the user in the service, representing the expectations the user has on the effect, and thus on the service provider. This partial definition of the service is also called the Requested Service [14]. The provider perspective defines the participation of the provider role, representing the expectations it has on the user. This partial definition of the service is also called the Offered Service [14]. There are more than just two actors in a domain in the service context. Different actors can play a role in a domain; some domains have one or more actors as a service provider. However, sometimes an agent can play the service provider role; for another service this agent can play the service consumer role. Our conceptual modeling method is not a domain specific model, so we will give a place to all potential actors who could be in any domain. Actors could be a service provider, service developer, service integrator, service broker, service consumer, service monitor, service certifier and system engineer (analyst) [13]. There have been agents who play roles which are represented by actors. That is to say: agents to mean entities of the real-world and actors to mean roles the real-world entities may play. Agents could be a person or organization, software system, service and legacy system [13]. In principle, an agent can take any of the roles identified by the actors

(e.g., a person can act as an operation provider), and vice versa: a role can be taken on by any agent (e.g., a service consumer can either be a person or a service) [13]. In other words, agents are actual people in a SOIS; actors are the roles that are played by actual people who are agents. In an information system, actors undertake some responsibilities or some roles. Sometimes an actor undertakes more than one responsibility, for example, the service provider can be a service certifier at the same time.

Some agents and their definitions are given below.

(1) Person or Organization, considered as human entities taking part in service oriented approach (SOA) interactions [13].

(2) Software System: A software entity that during its execution may offer one or more Services or just interact with other services [33].

(3)Legacy System: A software system implementing a traditional application (not a Service) [13].

Generic actors and their definitions are given below.

(1) Service Registry (Repository) is the role played by any entity that stores service descriptions for allowing service consumers to locate and further interact with service providers [13]. *Service registry (repository)* is responsible for storing provided services in the service level of an information system. First of all a service is searched from *service registry (repository)*. Service pool is handled by *service registry*.

(2) Service Integrator (service Composer) develops a composite service which is a kind of service [13]. It gets the service requests from service consumers in technical level and it searches the services in the service registry which is in the service level of the information system.

(3) Service Broker: an entity representing a registry queried by a Service Consumer for Service discovery purposes [33].

(4) Service Certifier: the entity that certifies some quality attributes of a Service [33]. *Service certifier* is responsible for certification of provided services in service level of information systems.

(5) Analyst (System Engineer) has responsibilities related to the business and service levels. The analyst (system engineer) looks at business requirements, business needs

and scenarios which come from business process level. At the same time the analyst offers a service according to the requirements and needs in the service level.

(6) Service provider is responsible for providing Offered Services in the service level of information systems. The service provider determines the service properties and provides services.

(7) Service operator is responsible for performing the services.

(8) Service Consumer makes service requests to the service level. It is responsible to requesting services.

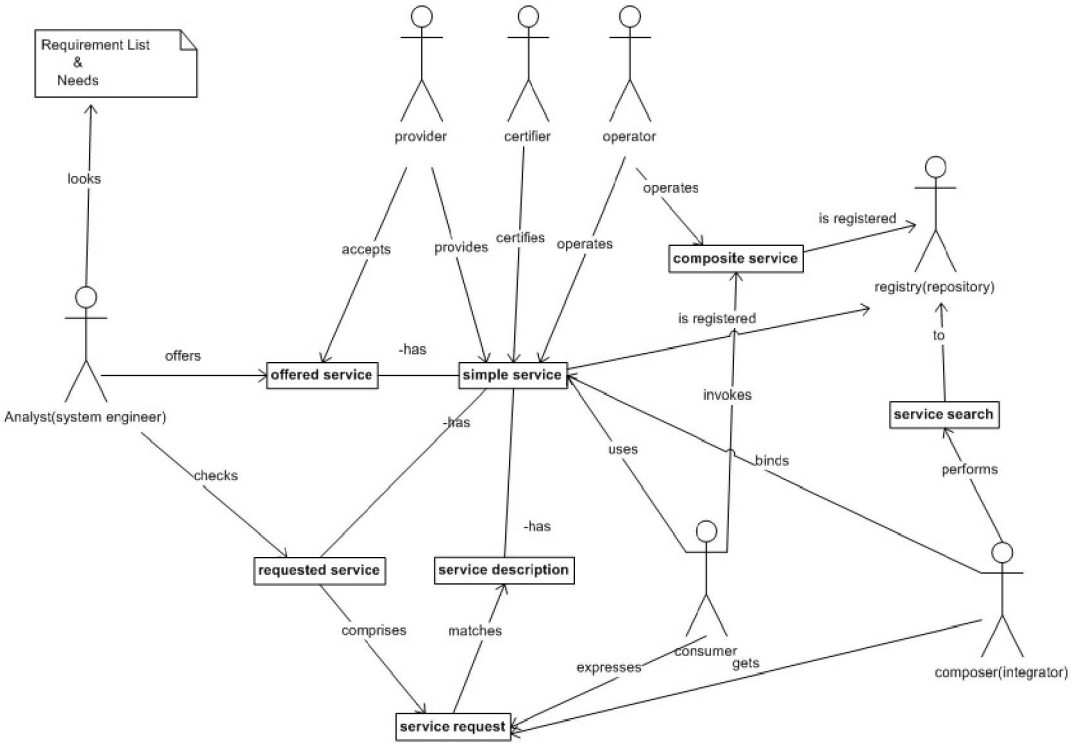


Figure 3.2 Concepts underlying the proposed method

In the healthcare example we can identify some of the agents and actors. According to the healthcare scenario mentioned in the scope of domain section above, the agents are determined as follows:

(1) Patient, (2) Medical Doctor, (3) Clinic, (4) Employee to answer phone calls.

Actors are determined as follows:

(1)Service Provider, (2) Service Consumer, (3) Service Operator, (4) Service Certifier, (5) Service Registry.

Patient is a service consumer, medical doctor is a service provider, Employee is a service operator, and Clinic is a service certifier and service registry to some services in the healthcare example. As we mentioned before, the agents can undertake different roles for different services as in the example.

3.1.3 Service Description

One of the most important steps of our conceptual modeling method is the service description step. In this step basic service characteristics and functionalities are identified. A service is fully defined by a service description, a published document or artifact that outlines the overall objective of the service and its inputs, purpose, outputs, scope, responsibility, governance, sustainability (provision period, maintenance and repair) and qualities of service provisioning [34]. The service description is available for searching, binding and invoking (Service Composition) by a service consumer. The service description implementation is realized through a service provider that delivers quality of service (QoS) requirements for the service consumer [34]. A service has many characteristics that an architect or analyst must consider and can specify as required. Also the services can have many attributes and effects that technology cannot define or measure. A service is a discrete domain of control that contains a collection of tasks to achieve related goals [31].

A service has two main elements that are Service Specification and Service Additional Information. Service Specification may involve both functional and non-functional specifications. Functional specification includes the service interface, service behavior, information on the service exceptions, and service operations. Non-functional specification includes the pricing information, service policies, service contract and service QoS attributes. Service Additional Information is usually provided by actors different from the service provider (e.g. by service consumers or by service certifiers). Service Additional Information may include information such as user ratings, measured QoS, usage history, deployment data, test suites and certificate [5] [13]. Besides these two main elements we should add one more dimension which is the scope of service description to service. Scope of service description includes some service description requirements which are service name, service type, service definition, service goal, security and dependencies.

Finally a service description has three categories of characteristics that are scope of service description category, service specifications category which has functional specifications and non-functional specifications, and service additional information category. All these categories include key concepts for the service description shown in Table 3.2. Each scope of service description, service specification and service additional information is a facet and each facet has some service properties (e.g. data types). The service consumer plays an important role in the creation of functional specifications of service description, but non-functional specifications are created by only the service provider. Service additional information aspect of service description is created in the technical level of SOIS, so it's called *service additional information* aspect. In Table 3.2 service description aspects are represented by the gray row. The elements of each column are mandatory to every service.

Table 3.2 Service description aspects and characteristics

Service Description Aspects and Characteristics			
Scope of Service	***Service Specification***		***Service Additional Information(filling after service publication)***
	Functional Spec.	***Non-Functional Spec.***	
Service Name	Service interface	Pricing information	User ratings
Service Type	Service behavior	Service policies	Measured QoS
Service Definition	Information on the service exceptions	Service QoS attributes.	Usage history,
Service Goal	Service operations	Service Contract (Preconditions, Post conditions and invariants)	Deployment data
Security			Certificate
Dependencies			Test suites

The key concepts of service description are clarified below.

Service Name: After the first two steps of conceptual modeling method, choosing a proper service name to identify the service. The service name should be a noun.

Service Type: Shows whether the service is automated or non-automated.

Service Definition: Which requirements are performed by the service? How is it performed?

Service Goal: Service is used for what purpose(s).

Service Contract: A set of conditions that must be met and accepted by a potential service consumer to enable successful communication.

Dependencies: If there are dependent elements, they should be written in this section of service description. (E.g. relevant requirement(s), relevant service(s)).

Service Operation: A service operation is the elementary part of a service and specifies the associated inputs, purpose (function, duty or obligations) and outputs (artifacts, products, outcomes or deliverables) [34].

Security: To create a service securely, the service should be repairable in each step of the conceptual modeling method. When a service is interrupted any time of creation or execution period, the service should be recovered to service goal fulfillment. The security of service should be covered by service policy.

Service Interface: Service interface is the mediator operator of service that is used by other services and consumers. This operator gives a chance to users that are services and consumers, for using functionalities of service. Also service interface gives a chance to generate Service Additional Information aspect of Service Description (to collect user ratings, to save usage history and to measure QoS). Service interface should be designed in application level of SOIS. In the service interface section of service description, an advice should be given to the technical level about how it should be designed.

Service Behavior: We will call this service expected behavior instead of service behavior. Because of that we can only guess the behavior of service before performing of service. According to precondition, post condition and invariants of the service, expected behavior is what the service acts will be.

Service Exceptions: Which situations are exceptions of created service?

Test Suites: This element is one of the dynamic elements of service description like user ratings, usage history. This element will be updated after testing the service and this element has three flags which are good, bad and to be revised. If the result is bad, the service is canceled or recreated. If it is good, there is no problem. And if it is to be revised, the service must be reviewed again.

Service Policy: A policy represents some constraint or condition on the use, deployment or description of an owned entity as defined by any participant [26].

Pricing Information: Cost calculation of the service must be done for each service by the analyst or the service provider.

In the healthcare example, the service taken was a consultation service. The consultation service details are given below. The table can be filled for other domain

services. In the table, service description aspects are represented by columns. Each aspect of service description has two cells in the table; the first cell includes item name which is written with bold characters and the second cell includes explanation for each item.

Table 3.3 Service details from healthcare information system

Service Scope		Service Specification			
		Functional Specification		Non-Functional Specification	
Item	Explanation	Item	Explanation	Item	Explanation
Service Name	Consultation service	**Service Interface**	Face to Face	**Service policies**	Patient has to make reservation, patient has to give right information about his/her complaints.
Service Type	Non-Automated	**Service Behavior**	The service provides understanding of patient's complaints and making sure about disease.	**Price**	Determine by expert of domain
Service Definition	Medical doctor starts treatment process of disease and makes a conversation to patient about his/her complaints.	**Service Exceptions**	The patients does not come his/her appointment, the patient does not give right information about his/her complaints.		
Service Goal	To make sure about patient's disease.	**Service Operations**	Patient comes to his/her appointment, patient tells complaints to medical doctor, Medical doctor decides to order some tests.		
Dependencies	Appointment service				

After determining the service aspects' details, we should examine relevant services' agents, actors and other details which are shown below in Table 3.4. The table includes five main sections which are *service name, requirement, determining stakeholder(s), triggering service (event)* and *service ID*. These sections are represented in the first column of the table. The second column of the table includes explanation of main sections. The determining stakeholder section of the table has two sub elements which are *related agents* and *related actors.*

Table 3.4 A service overview from healthcare information system

Service Name	Consultation service	
Requirement	Consultation	
Determining Stakeholder(s)	**Related Agents**	**Related Actors**
	Medical doctor	Service Provider
	Patient	Service Consumer
	Clinic	Service Registry, Service Certifier
Triggering Service (Event)	Appointment service	
Service ID	004	

Consultation service undertakes a consultation requirement in the healthcare example (for the consultation service medical doctor, patient and clinic are the agents). The agents of consultation service undertake three different responsibilities: i) medical doctor undertakes the service provider responsibility, ii) patient undertakes service consumer responsibility and iii) clinic undertakes service certifier and service registry responsibilities. The consultation service is triggered by an appointment service in the healthcare example. Triggering service is examined in the service composition section of this modeling method.

3.1.4 Service Composition

Service oriented information system approach involves atomic service structure. Atomic service is the smallest service and its structure provides dynamic SOIS. Our conceptual modeling method advices that SOIS should be comprised of atomic services as much as possible or it advices the components of service should be well defined. There have been two types of services which are composite services and simple services or atomic services and each kind of service has two types of service which are stateless and stateful service. Stateless means that there is no any status change in a service, there is also no initial state and final state. In other words stateless service's initial state is equal to final state. Stateful means that there is a status change in the service, there are also initial state, final state and may be intermediate states.

For example a patient wants to get recommendations about his/her disease from medical doctor who is the expert patient's disease. Before the consultation process the patient has to make a reservation by phone or using the internet. Reservation by phone is the simple and stateless service, because there isn't any status change in the service. A patient just calls the clinic and makes a reservation for his/her disease by talking to the assistant. Reservation on the internet is a simple (atomic) and stateful

service. There are interfaces to enter patient information. When a patient visits the web site of the clinic, the patient has to use an appointment service and then an interface comes to screen to collect patient's information. This interface is the initial state of simple stateful service. After that the system finds and reserves the proper time for the patient. This is the second state of simple stateful service. Finally the last step of appointment service is monitoring message to inform that is the final state of the simple stateful service.

Composite services comprise collaborating of simple services. A composite service can be seen as a combination of activities (which may be either atomic (simple) or composite service) [29]. When we turn the healthcare example, in that case curing is a service which is composite and stateful service. This service comprise with collaborating of many simple services which can be roentgenogram service, blood analysis service, urine analysis service, medical doctor evaluation etc.

The key issue is that how simple services can collaborate?

In the literature, generally service composition is used by web services at run-time dynamically, but service composition also has to cover non-automated services which do not include any automatic step such as meeting on the phone. The run time composition is preferred to compose services with programming languages. In the service composition approaches, the selection of simple services to create composite service is central to service composition; also selection of simple services is the first step of service composition. The idea is that simple services are selected by the composite service execution engine based on a set of criteria [28]. Criteria are QoS (Quality of services) can be execution price, execution duration, reputation, reliability and availability [28]. QoS (Quality of services) can change according to service composition approach. Some steps must be taken to build a service composition [29]. These steps are that 1) A process model specifying control and data flow among the activities has to be created. 2) Concrete services to be bound to the process activities need to be discovered. The service composer usually interacts with a broker, e.g. a service registry, in order to look up services which match with certain criteria. 3) The composite service must be made available to potential clients. Again the broker used to publish a description and the physical access point of the service. 4) During invocation of a composite service a coordinating entity (process

execution engine) may manage the control flow and data flow according to the specified process model [29]. After selection of services according to criteria, services have to bind to compose services [29].

In our conceptual modeling method, service consumer requests a service with quality of service criteria that mentioned above or functional properties of services. When the requests meet the service's features according to requests of consumer, related services automatically collaborate with each other. This collaborating process occurs at run time in the literature. Our CM advices that service descriptions, service policy, components of services, operation of services, service specifications and service functions are prepared in design time before run time (implementation level) to execution of composite services (Figure 3.2).

Service composition of conceptual modeling method says that a composite service is invoked by service consumer with a service request. The service composer gets the service request and asks to the service registry (service repository) that can service pool answer this service request? If the service request does not match a simple service from service pool, the service composer which may be a machine, create an orchestration to orchestrate composite service. In the orchestration phase of our conceptual modeling method advises that service request tells us what is the goal of consumer, who requests, what does he/she want?, in service description step of conceptual modeling method the triggering service is defined for each service. Service composer searches services according to service request (The goal of consumer) and looks the triggering service of each service, according to triggering service the service composer binds the services which are found during searching. At the end of this process we have a composite service to realize service consumer request.

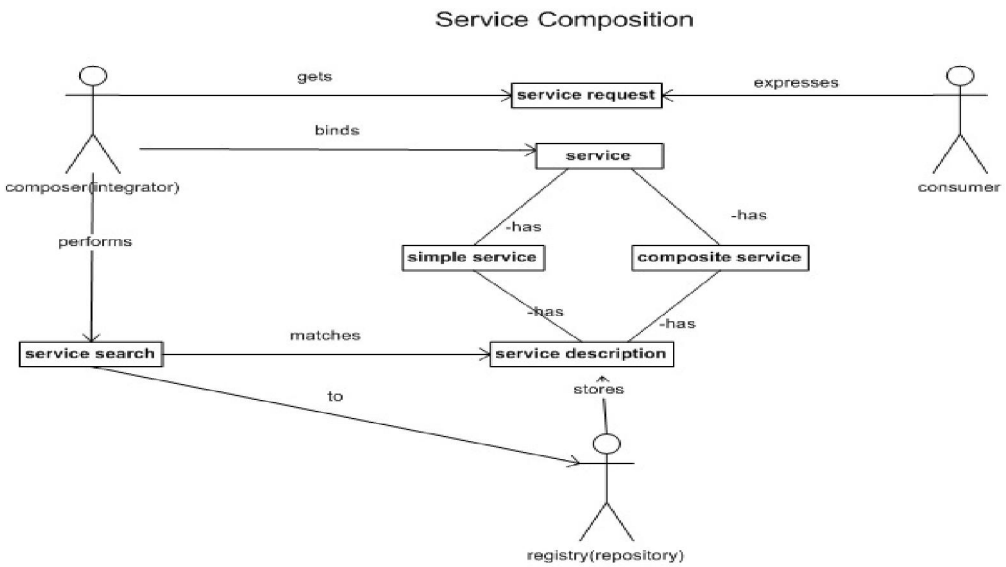


Figure 3.3 Service Composition Process

3.1.5 Service Monitoring

Service monitoring is a picture of overall relevant service. A service is designed before this step of conceptual modeling method so; this step shows us how appropriate is designed service, how strong is designed service, how composable is designed service etc. In other words service monitoring gives us an idea about relevant service; should be alive or not, should be developed or not or should be enough or not. In our conceptual modeling method when a service is designed, some steps which are determining service specifications, determining service additional information and service composition; are followed. Each step of conceptual modeling method provides ability (functionality) to relevant service. To measure the functionalities or appropriateness (service is enough or not, good or bad) of service we need a thing (tool, interface, storage anyway) that monitors some data about relevant service. Each facet (service specification and service additional information) of service has some properties; service monitoring measures qualities of them. Actually the issue is not that should be there any service monitoring, service monitoring is necessary to measure some properties for quality of service or appropriateness of service (enough or not, good or bad) obviously. The main issue is that what metrics should be used in service monitoring for quality of service?

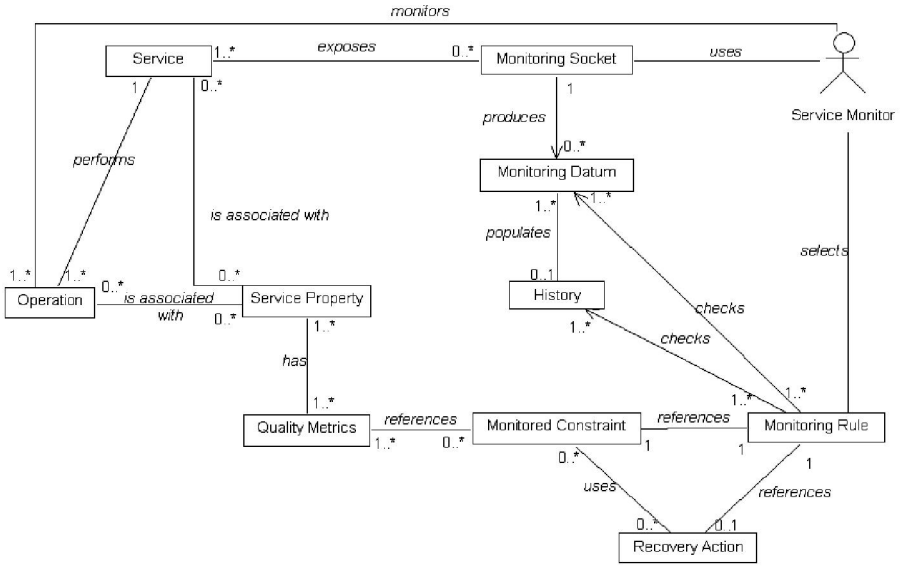


Figure 3.4 Service Monitoring [adopted from 13]

Unquestionably each service has different properties and specifications, so each service should be evaluated individually and each service should have different quality metrics to measure quality of properties. Therefore when service is designed, quality metrics should be identified for each service individually. Generally quality metrics of these services' properties may cover that execution price, execution duration, reliability, availability, user ratings etc. [28].

When we look at the patient – medical doctor example, possible services have different quality metrics to monitor service appropriateness. User ratings for the speech of assistant are metrics to monitor for non-automated appointment service. Time and price are metrics to monitor for roentgenogram service and blood analysis service etc.

Finally, when we design a service we have to determine some metrics to measure appropriateness of relevant service as the final step of our conceptual modeling method. This final step is called service monitoring. Service monitoring provides us some advantages and some ideas about relevant service, service repairing, service development and new service creation or service removing.

3.1.6 Conclusion

The major advantages of SOCMM is that (1) the steps of SOCMM occur quickly and dynamically, (2) the created services are reusable for the different information

systems in the different domains, (3) the model transformation could be realized between the levels of abstraction. The second (determining agents and actors) and the third (service description) steps are not sequential. They could be occurred simultaneously. If service's policies are updated, services can be reusable for the different domains.

3.2 Comparison with other Service Conceptual Modeling Methods

We proposed a framework to evaluate service conceptual models in literature review section of this study. After the SOCMM is implemented we can mention the second evaluation that it should be about key concepts which are defined in SOCMM. The Table 3.5, which is shown below, includes a comparison about key concepts' definitions.

Table 3.5 CM methods vs. key concepts of SOIS

	Agent	Actor	Service Description	Service Goal	Service Type	Service Interface	Service Policy	Service Behavior	Service Operation
OASIS	---	---	+		---	+	+	+	---
COSMO	---	---	---	+	---	+	---	+	---
SeCSE	+	+	+	---	**---**	**O**	**O**	**O**	+
SOCMM	+	+	+	+	+	+	+	+	+

Table 3.5 Cont. CM methods vs. key concepts of SOIS

	Offered Service	Requested Service	Service Security	Triggering Service	Service Price Information	Service Composition	Service Monitoring
OASIS	**O**	---	**O**	---	---	+	---
COSMO	---	---	---	---	---	+	---
SeCSE	---	---	---	---	+	+	+
SOCMM	+	+	+	+	+	+	+

(+) Fully articulated. (**O**) Implicitly articulated. (---) Not mentioned.

Chapter 4

Demonstration and Viability of SOCMM

4.1 A Case Study about Healthcare

In this section of the thesis a case study about a healthcare will be used to demonstrate SOCMM (Service Oriented Conceptual Modeling Method). Firstly, we will describe a scenario from the viewpoint of a service consumer as an analyst or as a system engineer. Map for creating SOCMM products about healthcare information system is shown in Figure 4.1.

4.1.1 Scope of Domain to Case Study

For the scope of domain step of the conceptual modeling method a scope definition is needed, which was mentioned in the scenario and the requirement list according to the domain. To realize some steps of the conceptual modeling method, conventional analysis techniques could be used. For example, a specific method is not proposed to examine the requirements of the domain, so they could be examined with the conventional analysis techniques.

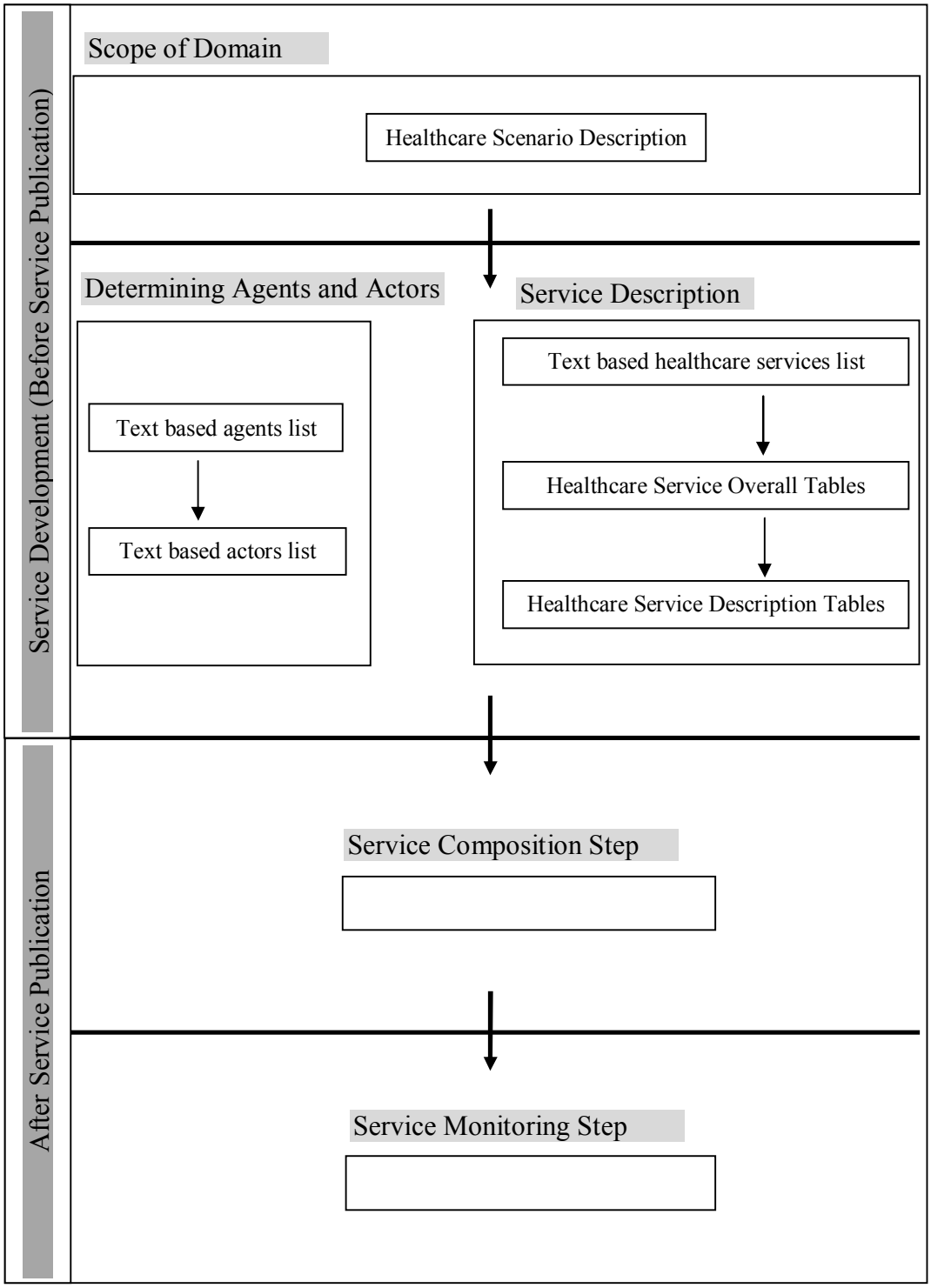


Figure 4.1 SOCMM products for healthcare information system.

4.1.1.1 Scenario

A patient wants to have a treatment about his/her disease. For this reason he/she decides to go to a clinic which is specialized in the area of the disease. First of all he/she calls the clinic to acquire information about the standard procedure for the treatment. He/she wants to talk an employee of the clinic and asks some questions about the rules of procedure for the treatment. After learning about the procedures, the patient starts to carry out the steps of the procedure. The first rule of the procedure is to make a reservation. There are two ways of making a reservation: either by making a phone call or submitting a form on-line over the Internet. If the patient wants to make a reservation by making a phone call he/she has to talk an employee of the clinic to book the medical doctor who is an expert about the disease. After making the reservation with the medical doctor, the patient is supposed to make a reservation for the examination. If the patient wants to make an on-line reservation over the Internet, he/she has to enter the web site of the clinic and then click on the reservation link, thereafter he/she needs to choose a medical doctor who is one of the experts of clinic's medical doctors about his/her disease. In choosing a medical doctor, the patient is able to select the most convenient time slot from the list of available time slots displayed on the page. When the patient goes to the clinic for the appointment, the medical doctor (MD) calls the patient for an examination. MD meets with the patient and the patient to complete some tests for the examination of the symptoms in order to be able to identify the disease. The patient is finally diagnosed according to the results of the tests. If the MD has every confidence that the diagnosis of the illness is made successfully, then the procedure for its treatment is started. At this point the MD gives information to the patient about the disease as well as the medication (solution techniques and the method which is followed to solve problem). Some medicines about the disease can be given or the patient may be given an advice for a surgery after these processes. In either case there will be control meetings to keep in checking up the disease.

According to the scenario some requirements can be listed as follows: *Reservation, Information flow from employee to patient, Information flow from medical doctor to patient, consultation, treatment, control meetings, solutions to treatment.*

4.1.2. Determining Agents and Actors

According to the scenario the agents are determined as follows:
(1) Patient, (2) Medical doctor, (3) Clinic, (4) Employee to answer phone calling.

The actors are determined as follows:
(1)Service Provider, (2) Service Consumer, (3) Service Operator, (4)Service Certifier, (5) Service Registry.

4.1.3. Service Description to Case Study

After determining agents, actors and scope of the domain the services are examined in the service description step of the conceptual modeling method. In this step first of all we should decide services and its identifications according to business requirements, needs and scenario. From the service consumer perspective there must be necessary services and optional services for the relevant disease along with mandatory requirements. The optional services are for competition with other clinics. Some forms (these forms can be used for each service) are used to determine a service and its specifications such as functional and non-functional specifications for the healthcare scenario according to the conceptual modeling method. The necessary services are proposed as follows:

Table 4.1 Appointment service by phone specifications

Service Scope		Service Specification			
		Functional Specification		Non-Functional Specification	
Item	Explanation	Item	Explanation	Item	Explanation
Service Name	Appointment service by phone	**Service Interface**	Phone	**Service policies**	Service is performed if a request comes, Service is performed if there are available time slots, Service is performed, if patient wants to reserve.
Service Type	Non-Automated	**Service Behavior**	The service provides information to patient about available time slots of medical doctor to make reservation	**Price**	Determine by expert of domain
Service Definition	Provide a making reservation to patient by the phone. Call center employee tell the available time of medical doctor who is expert about patient disease. After choosing available time by patient reservation is realized.	**Service Exceptions**	If phone calling is interrupted by some infrastructure constraints, service is interrupted		
Service Goal	Realized reservation by the phone calling	**Service Operations**	Request phone calling by patient, quick search for available time slots, reservation realization.		
Dependencies	Appointment service by the internet.				

Table 4.2 Appointment service by the internet specifications

Service Scope		Service Specification			
		Functional Specification		Non-Functional Specification	
Item	Explanation	Item	Explanation	Item	Explanation
Service Name	Appointment service by the internet	**Service Interface**	Web site	**Service policies**	Service is performed if a request comes, Service is performed if there are available time slots, and Service is performed if patient wants to reserve, Service is performed if patient submit his/her choices.
Service Type	Automated	**Service Behavior**	The service provides information to patient about available time slots of medical doctor to make reservation	**Price**	Determine by expert of domain
Service Definition	Provide a making reservation to patient by the internet. When a patient click this service on the web site the system check and shows the available time slots of medical doctor who is expert about patient disease. After choosing available time by patient reservation is realized.	**Service Exceptions**	If the internet access is interrupted by some infrastructure constraints, service is interrupted		
Service Goal	Realized reservation by the internet.	**Service Operations**	Request to reservation by web site, shows available time slots, realizes reservation.		
Dependencies	Appointment serviceby phone				

Table 4.3 Information service about processes specifications

Service Scope		Service Specification			
		Functional Specification		Non-Functional Specification	
Item	Explanation	Item	Explanation	Item	Explanation
Service Name	Information service about processes	**Service Interface**	Phone	**Service policies**	Service is performed if a request comes, Service is performed if patient asks some questions about treatment processes.
Service Type	Non-Automated	**Service Behavior**	The service provides information to patient about available time slots of medical doctor to make reservation	**Price**	Determine by expert of domain
Service Definition	Provide useful information to patient about treatment processes. When a patient calls to clinic and asks some questions about treatment processes, call center employee gives information to patient.	**Service Exceptions**	If phone calling is interrupted by some infrastructure constraints, service is interrupted		
Service Goal	Produce useful information to patients about treatment processes in the clinic.	**Service Operations**	Request to get info by phone, tells steps of treatment.		
Dependencies	-				

Table 4.4 Consultation service specifications

Service Scope		Service Specification			
		Functional Specification		Non-Functional Specification	
Item	Explanation	Item	Explanation	Item	Explanation
Service Name	Consultation service	**Service Interface**	Face to Face	**Service policies**	Patient has to make reservation to meeting, patient has to give right information about his/her complaints.
Service Type	Non-Automated	**Service Behavior**	The service provides understanding of patient's complaints and making sure about disease.	**Price**	Determine by expert of domain
Service Definition	Medical doctor starts to treatment process of disease and makes a conversation to patient about his/her complaints.	**Service Exceptions**	The patients does not come his/her meeting, the patient does not give right information about his/her complaints.		
Service Goal	To make sure about patient's disease.	**Service Operations**	Patient comes to his/her meeting, patient tells complaints to medical doctor, Medical doctor decides to make some tests.		
Dependencies	Appointment service				

Table 4.5 Information service about disease specifications

Service Scope		Service Specification			
		Functional Specification		Non-Functional Specification	
Item	Explanation	Item	Explanation	Item	Explanation
Service Name	Information service about disease	**Service Interface**	Face to Face	**Service policies**	Service is performed if patient comes to meeting; service is performed if patient has disease.
Service Type	Non-Automated	**Service Behavior**	The service provides information to patient about his/her disease to struggle disease.	**Price**	Determine by expert of domain
Service Definition	The medical doctor gives information to patient about his/her disease. After the medical doctor is sure about disease, patient takes some information about disease	**Service Exceptions**	If patient does not come his/her meeting the service cannot be realized.		
Service Goal	Giving information to patient about how to struggle to his/her disease	**Service Operations**	Make sure about disease, giving information to patient about disease		
Dependencies	Consultation service.				

Table 4.6 Solution creation service specifications

Service Scope		Service Specification			
		Functional Specification		Non-Functional Specification	
Item	Explanation	Item	Explanation	Item	Explanation
Service Name	Solution Creation Service	**Service Interface**	Face to Face	**Service policies**	Service is performed if the medical doctor makes sure disease, If the medical doctor is an expert about disease, service is preformed.
Service Type	Non-automated	**Service Behavior**	The service provides way of treatment.	**Price**	Determine by expert of domain
Service Definition	According to tests the medical doctor decides how can be solved the disease? What is the way of solution? Which steps are applied to solution?	**Service Exceptions**	If the patient does not have tests' results and if the medical doctor cannot be sure about disease the service becomes unavailable.		
Service Goal	Deciding treatment process to solution for disease.	**Service Operations**	Make sure about disease, deciding way of treatment, giving information to patient about solution.		
Dependencies	Roentgenogram Service, create solution service, urine analysis service, blood analysis service.				

Table 4.7 Meetings to control service specifications

Service Scope		Service Specification			
		Functional Specification		Non-Functional Specification	
Item	Explanation	Item	Explanation	Item	Explanation
Service Name	Meetings to control service	**Service Interface**	Face to Face	**Service policies**	Service is performed if patient apply treatment components, Service is performed if patient comes to control meetings.
Service Type	Non-automated	**Service Behavior**	The service provides under the control to disease.	**Price**	Determine by expert of domain
Service Definition	Provide a control on the patient's disease. In the treatment process checking to disease is required. Checking of disease is realized with control meetings.	**Service Exceptions**	If the patient does not come control meetings the service cannot be realized. And if patient does not apply the treatment components the service cannot reach the service goal.		
Service Goal	Keep in check the disease.	**Service Operations**	Reservation to control meetings, checking the disease.		
Dependencies	Roentgenogram Service, create solution service, urine analysis service, blood analysis service.				

Table 4.8 Blood analysis service specifications

Service Scope		Service Specification			
		Functional Specification		Non-Functional Specification	
Item	Explanation	Item	Explanation	Item	Explanation
Service Name	Blood Analysis Service	**Service Interface**	Blood test machine	**Service policies**	Service is performed if the medical doctor wants to see blood tests, patient gives his/her blood and the machine measures values.
Service Type	Automated	**Service Behavior**	The service provides test results of blood.	**Price**	Determine by expert of domain
Service Definition	If medical doctor wants to get blood analysis result to sure about disease, patient's blood is taken to test.	**Service Exceptions**	The medical doctor does not want to see blood analysis result. The machine does not work.		
Service Goal	To measure patient's blood values.	**Service Operations**	The medical doctor wants to see blood results, patient gives his/her blood to test, the test machine measures the blood values.		
Dependencies	Create solution service.				

Table 4.9 Urine analysis service specifications

Service Scope		Service Specification			
		Functional Specification		Non-Functional Specification	
Item	Explanation	Item	Explanation	Item	Explanation
Service Name	Urine Analysis Service	**Service Interface**	Urine test machine	**Service policies**	Service is performed if the medical doctor wants to see urine tests, patient gives his/her urine and the machine measures values.
Service Type	Automated	**Service Behavior**	The service provides test results of urine.	**Price**	Determine by expert of domain
Service Definition	If medical doctor wants to get urine analysis result to sure about disease, patient's urine is taken to test.	**Service Exceptions**	The medical doctor does not want to see urine analysis result. And the machine does not work.		
Service Goal	To measure patient's urine values.	**Service Operations**	The medical doctor wants to see urine results, patient gives his/her urine to test, the test machine measures the urine values.		
Dependencies	Create solution service.				

Table 4.10 Roentgenogram service specifications

Service Scope		Service Specification			
		Functional Specification		Non-Functional Specification	
Item	Explanation	Item	Explanation	Item	Explanation
Service Name	Roentgenogram Service	**Service Interface**	roentgenogram machine	**Service policies**	Service is performed if the medical doctor wants to see roentgenogram films, roentgenogram films are taken and the machine takes roentgenogram films.
Service Type	Automated	**Service Behavior**	The service provides roentgenogram films.	**Price**	Determine by expert of domain
Service Definition	If medical doctor wants to get roentgenogram films to sure about disease, patient's roentgenogram films are taken to test.	**Service Exceptions**	The medical doctor does not want to see roentgenogram films. And the machine does not work.		
Service Goal	To imagine patient's roentgenogram films.	**Service Operations**	The medical doctor wants to see roentgenogram films, roentgenogram films are taken, and the roentgenogram machine takes the roentgenogram films.		
Dependencies	Create solution service.				

Table 4.11 Appointment service by phone

Service Name	Appointment service by phone	
Requirement	Reservation by the phone calling	
Determining Stakeholder(s)	**Related Agents**	**Related Actors**
	Patient	Service Consumer
	Employee	Service Operator
	Clinic	Service provider, Service Registry, Service Certifier
Triggering Service (Event)	Information service about processes	
Service ID	001	

Table 4.12 Appointment service over the internet

Service Name	Appointment service by the internet	
Requirement	Reservation by the internet	
Determining Stakeholder(s)	**Related Agents**	**Related Actors**
	Patient	Service Consumer
	Web Site	Service Operator
	Clinic	Service provider, Service Registry, Service Certifier
Triggering Service (Event)	Information service about processes	
Service ID	002	

Table 4.13 Information service about processes

Service Name	Information service about processes	
Requirement	Information flow from employee to patient	
Determining Stakeholder(s)	**Related Agents**	**Related Actors**
	Patient	Service Consumer
	Employee	Service Operator
	Clinic	Service provider, Service Registry, Service Certifier
Triggering Service (Event)	She/he decides to go a clinic which is expert his/her disease.	
Service ID	003	

Table 4.14 Consultation service

Service Name	Consultation service	
Requirement	Consultation	
Determining Stakeholder(s)	**Related Agents**	**Related Actors**
	Medical doctor	Service Provider
	Patient	Service Consumer
	Clinic	Service Registry, Service Certifier
Triggering Service (Event)	Appointment service	
Service ID	004	

Table 4.15 Information service about disease

Service Name	Information service about disease	
Requirement	Information flow from medical doctor to patient	
Determining Stakeholder(s)	**Related Agents**	**Related Actors**
	Patient	Service Consumer
	Medical doctor	Service Operator, Service provider, Service Certifier
	Clinic	Service Registry
Triggering Service (Event)	Blood Analysis service, Roentgenogram service, urine analysis service.	
Service ID	005	

Table 4.16 Meetings to control service

Service Name	Meetings to Control Service	
Requirement	Control meetings	
Determining Stakeholder(s)	**Related Agents**	**Related Actors**
	Patient	Service Consumer
	Medical doctor	Service Operator, Service provider, Service Certifier
	Clinic	Service Registry
Triggering Service (Event)	Create solution service	
Service ID	006	

Table 4.17 Solution creation service

Service Name	Solution Creation Service	
Requirement	Determining solution techniques.	
Determining Stakeholder(s)	**Related Agents**	**Related Actors**
	Patient	Service Consumer
	Medical doctor	Service Operator, Service provider, Service Certifier
	Clinic	Service Registry
Triggering Service (Event)	Consultation Service	
Service ID	007	

Table 4.18 Blood analysis service

Service Name	Blood Analysis Service	
Requirement	Treatment Process	
Determining Stakeholder(s)	**Related Agents**	**Related Actors**
	Patient	Service Consumer
	Lab Employees (Out of scenario scope)	Service Operator,
	Clinic	Service provider, Service Certifier , Service Registry
Triggering Service (Event)	Consultation Service	
Service ID	008	

Table 4.19 Urine analysis service

Service Name	Urine Analysis Service	
Requirement	Treatment Process	
Determining Stakeholder(s)	**Related Agents**	**Related Actors**
	Patient	Service Consumer
	Lab Employees (Out of scenario scope)	Service Operator,
	Clinic	Service provider, Service Certifier , Service Registry
Triggering Service (Event)	Consultation Service	
Service ID	009	

Table 4.20 Roentgenogram Service

Service Name	Roentgenogram Service	
Requirement	Treatment Process	
Determining Stakeholder(s)	**Related Agents**	**Related Actors**
	Patient	Service Consumer
	Lab Employees (Out of scenario scope)	Service Operator,
	Clinic	Service provider, Service Certifier , Service Registry
Triggering Service (Event)	Consultation Service	
Service ID	010	

We examined required services shown above and now we will talk about optional services.

Table 4.21 Journey Service

Service Name	Journey Service	
Requirement		
Determining Stakeholder(s)	**Related Agents**	**Related Actors**
	Patient	Service Consumer
	Tour Company	Service Operator, Service Provider, Service Certifier
	Clinic	Service Registry
Triggering Service (Event)	Appointment service	
Service ID	011	

At this point some recovery services can be identified to recover some misfortunes.

Table 4.22 Feedback Service

Service Name	Feedback Service	
Requirement		
Determining Stakeholder(s)	**Related Agents**	**Related Actors**
	Patient	Service Consumer
	Call center employee	Service Operator
	Clinic	Service Registry, Service Provider, Service Certifier
Triggering Service (Event)	If medical doctor is not available at the reservation time of patient.	
Service ID	012	

Table 4.23 Gift service

Service Name	Gift Service	
Requirement		
Determining Stakeholder(s)	**Related Agents**	**Related Actors**
	Patient	Service Consumer
	Employee	Service Operator
	Clinic	Service Registry, Service Provider, Service Certifier
Triggering Service (Event)	If medical doctor is not available at the reservation time of patient.	
Service ID	013	

As mentioned before there have been two types of services which are Composite Services and simple services or atomic services. Each type of service has two different types of service which are stateless and stateful service, in SOIS. Stateless means that there is no any status change in a service, there is also no initial state and final state. In other words stateless service initial state is equal to final state. Stateful means that there is a status change in a service, there are also initial state, final state and may be intermediate states.

For example a patient wants to get recommendations about his/her disease from medical doctor who is the expert patient's disease. Before the consultation process the patient has to make a reservation by phone or over the internet. Reservation by phone is the simple and the stateless service, because there is no any status change in the service. The patient just calls the clinic and makes a reservation for his/her disease by talking the assistant. Reservation over the internet is the simple (atomic) and the stateful service. There are interfaces to enter the patient's information. When the patient visits the web site of the clinic, the patient has to enter the appointment service to use this service. Then an interface comes to screen to collect the patient's information, the interface is the initial state of the simple stateful service. After that the system finds and reserves the proper time slots for the patient. This is the second state of the simple stateful service. Finally the last step of the appointment service is the monitoring message to inform that is the final state of the simple stateful service.

4.1.4 Service Composition

Service composition of service oriented conceptual modeling method says that a Composite Service is invoked by service consumer with a service request. Service composer gets the service request and asks to service registry (service repository)

that can service pool answer this service request? If the service request does not match any simple service from service pool, service composer which could be a machine, a person or software, create an orchestration to orchestrate Composite Service. A service request could include answers of some questions that are what is the goal of the consumer? Who does the request? And what does he/she want? In service description step of conceptual modeling method the triggering service which could help for service composition, is defined for each service. Service composer searches services according to service request (The goal of consumer) and service composer looks the triggering service (if there exist) of each service, according to triggering service the service composer could bind the services which are found during searching. The request also could be searched in service policy section of service. The aim of service composition is that taking service request from service consumer, searching requests, matching requests to relevant services' policies and definitions and finally binding them. At the end of this process we have a composite service to realize service consumer's request.

In the case of healthcare when a patient wants to treat about his/her disease, there is no any defined treatment service in the service registry. Treatment service should be a composite service which comprises two or more simple services. When the solution creation service, the consultation service collaborate with each other and they are bound each other, the treatment service is created. According to result of consultation service the blood analysis, the urine analysis and the roentgenogram analysis services could be added to the treatment composite service. When we look at the triggering service (event) of bound services, we can see that triggering service or triggering event refers to each other.

4.1.5. Service Monitoring to Case Study

As mentioned before service monitoring of services is realized after service publication. The aim of service monitoring is to see appropriateness of created services. To measure the functionalities or appropriateness (service is enough or not, good or bad) of service we need a thing (tool, interface, storage anyway) that monitors some data about relevant service. Each facet (service specification and service additional information) of service has some properties; service monitoring measures qualities of them. Actually the issue is not that should be there any service

monitoring, service monitoring is necessary to measure some properties for quality of service or appropriateness of service (enough or not, good or bad) obviously, the main issue is that What metrics should be measure by service monitoring for quality of service?

Unquestionably each service has different properties and specifications, so each service should be evaluated individually and each service should have different quality metrics to measure quality of properties. Therefore when service is designed, quality metrics should be identified for each service individually. Generally quality metrics of these services' properties may cover that execution price, execution duration, reliability, availability, user ratings etc. [28].

When we look at the patient – medical doctor example, possible services have different quality metrics to monitor service appropriateness. While user ratings and the speech of assistant like merrily and satisfactorily are metrics to monitor in the non-automated appointment service. Time and price are metrics to monitor for roentgenogram service and blood analysis service etc.

4.2. Checking Viability of Proposed Conceptual Modeling Method via a Course Registration System

Registration information system at a university is examined to illustrate and to discuss viability of the proposed conceptual modeling method (SOCMM). Campus Online software involves course registration processes at a University in Istanbul. In this section of study, some problematic cases are examined in Campus Online registration process and they are illustrated that how to solve these problems with service oriented information system point of view. Service orientation approach is used to solve for problematic cases of the registration information system in Campus Online. As mentioned in previous sections of this study, our claim is that conventional information systems have some problems, due to these problems; one can find some faulty information systems. Map for creating SOCMM products about course registration information system is shown in Figure 4.2. True-life problematic cases are examined about Campus Online in this section.

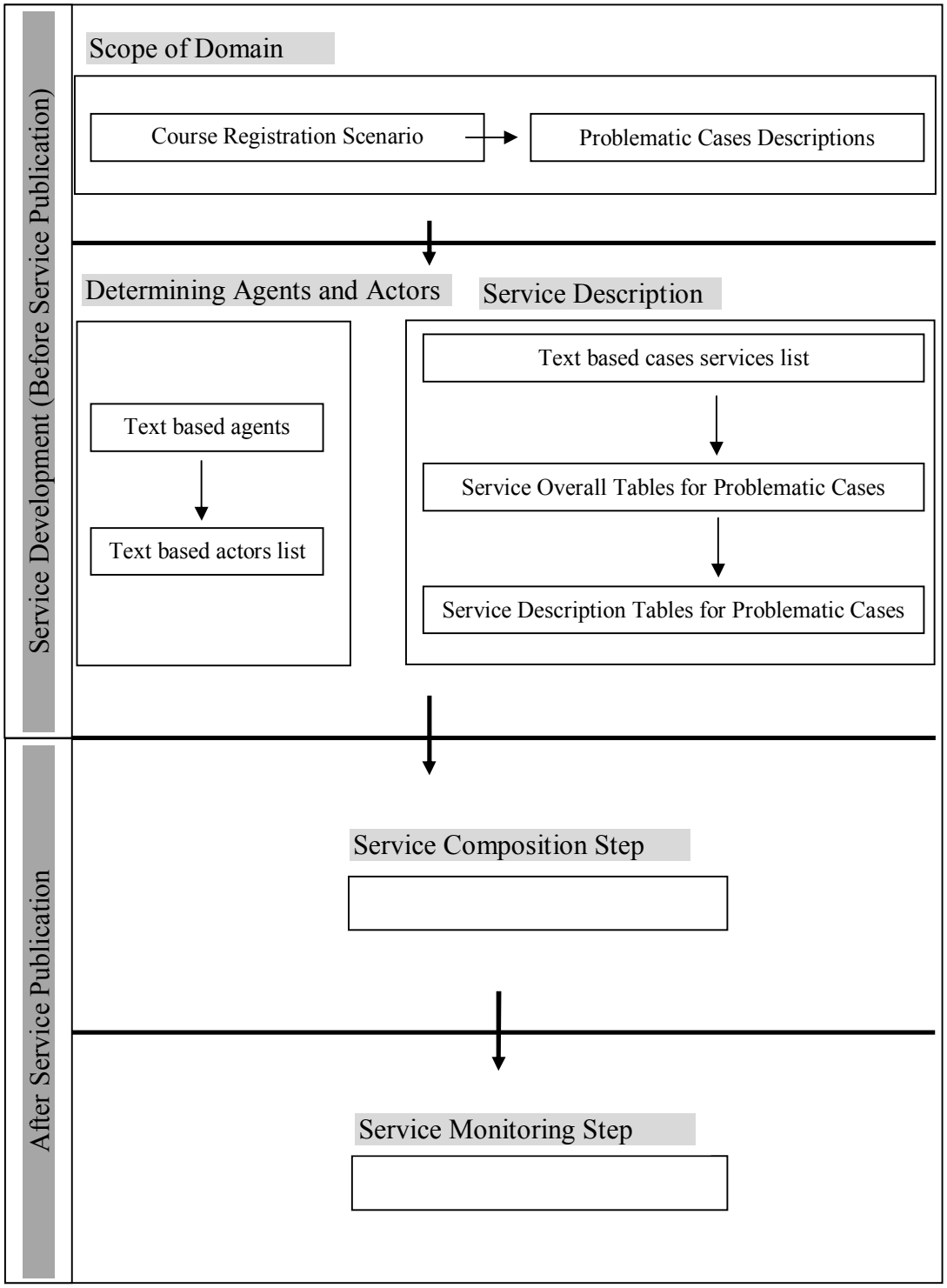


Figure 4.2 SOCMM products for course registration information system.

4.2.1. Campus Online (Special Software)

A university has its own, in-house developed course management system. The system includes various actors and is used by many people; finance department members, library, faculty members, students. Course management system follows mostly registration, course selection and other main processes electronically. But some other uncommon cases, processes are followed by paper files between the faculty members and students. However, such situations sometimes lead some delays, conflicts in the university.

The processes at the university can be characterized in two ways; primary or core processes and supportive processes: One of the primary processes in this foundation is the Course Registration Process with Campus Online which is the core process in the course management system. This process starts with the students who want to register and select courses online for the coming period of education. Actually, to start this process students have to fulfill the needs, requirements for such registration online; must have no holds in their accounts. This process has its own period to be done; not continuously performed during a semester. This process is monitored by the advisors of the students who are the faculty members that are defined before registration period. The process ends with the advisors' approval. The other primary processes are the Freshman Student, Foreign Student, Transfer Student, and Special Student Registration Processes. These processes are followed in paper files and electronic files.

Supportive Processes in this foundation are the Administration Process and Budgeting Process of the Finance Department. These processes can be directly linked with the Course Management System of the university. Because without these processes support; the course management cannot be maintained successfully. Some uncommon cases are supported and solved by the administrative processes with paper files.

4.2.2.Applying Conceptual Modeling Method to Registration Information System

To check viability of the proposed conceptual modeling method (SOCMM) we shall apply the conceptual modeling method to the course registration information system.

There have been some structured steps in the conceptual modeling method. These are that (1) Scope of Domain for relevant SOIS (2) Determining Agents and Actors, (2a) Deciding IS Requirements (taken from business level), (3) Service Description (3a) Determining Service Specifications (3b) Determining Service Additional Information, (4) Service Composition, (5) Service Monitoring.

4.2.2.1 Scope of Domain

The registration process starts with opening campus online to registration. Students select and add courses among open courses. There have been two error checking mechanisms the first is realized by the software and the second is realized by students' advisors. When a student completes his/her course selection process without software errors, the student sends his/her program to the advisor for approval. The advisor checks the student's program and the student's registration information. Then the advisor approves program if it has no errors. In the Campus Online, the registration process assumed to work properly until the advisors' approval. When we look at the experiences about registration process, a problematic situation could be emerged after approval. When the student's program is approved by his/her advisor, this means that the registration process is done successfully and the student can study the selected courses for the relevant semester.

4.2.2.1.1 True-life Case 1: Course Cancellation

In the 2010 fall semester, although a student's program was approved by his/her advisor in the registration period, one of the registered courses was closed by the administrative board. When the course was cancelled, the re-registration period or the add-drop period was ended, so the student had to struggle to take a new course instead of the cancelled course. This special case is undefined in Campus Online, so Campus Online software is unavailable for the course re-registration after the add-drop period. In this case the problems are that a) Course cancellation was not informed to the student. b) This case is not defined in Campus Online. c) The registration and the re-registration (add-drop) period are passed, so this undesired situation is tried to solve with non-automated processes which involves paper files and electronic files.

4.2.2.1.2 True-Life Case 2: Transfer a Student from One Course to Another

A student completed his registration process successfully in the 2009 at the university. One of the taken courses reached excessive students, so the administrative board decided that a new course section should be opened and the some registered students should be transferred to the new course section. This decision was applied and the some registered students were transferred to the new section but the students who were transferred, were unaware of this case. Until the end of the semester the students appeared in the wrong course section and they took the exams from a wrong course section. In this case the problems are that a) Transfer was not informed to the students. b) This case is not defined on Campus Online.

We can see the flow chart of the campus online system shown below. In the defined processes, there has not been what should be done when a course cancellation occurs and when a student transfer from one course to another.

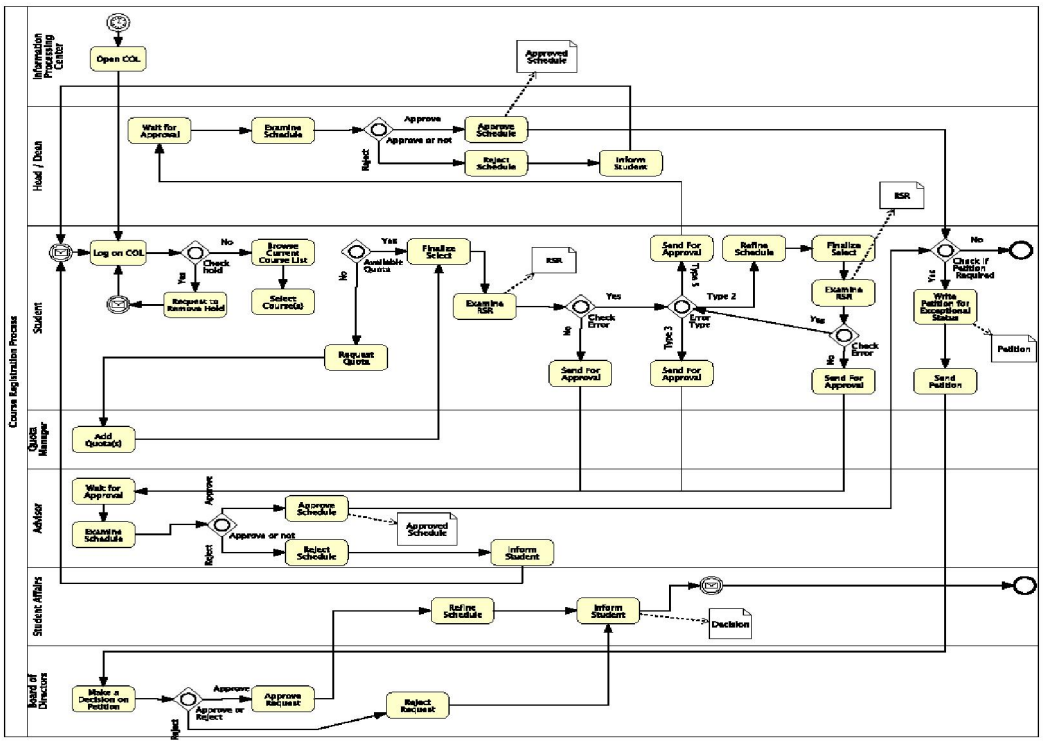


Figure 4.3 AS-IS of course registration in campus online

4.2.2.2 Determining Agents and Actors

According to domain scenario which is mentioned above, the agents are determined as follows:

(1) Student, (2) Instructor, (3) Registrar Office, (4) Advisor (5) Campus Online (software) (6) Administrative Board.

Actors are determined as follows:

(1) Service Provider, (2) Service Consumer, (3) Service Operator, (4) Service Certifier, (5) Service Registry.

4.2.2.3 Service Description to Case Study

After determining agents and scope of domain we examine services which are named service description in the conceptual model. In this step first of all we should decide which services and their identifications should be there? Services in this section of study are only related to problematic parts of registration process. We can use a form (This form should be used for each service.) to determine a service of registration scenario according to conceptual modeling method (SOCMM) and we propose necessary services as follows:

- Announcement Service
- Course Selection Service
- Error Detection Service
- Monitoring Info Service
- Approval Service
- Course Evaluation Service

The tables shown below includes five main sections that are *service name, requirement, determining stakeholder(s), triggering service (event)* and *service ID*. These sections are represented in the first column of table. The second column of table includes explanation of main sections. The determining stakeholder section of table has two sub elements which are *related agents* and *related actors*.

Table 4.24 Announcement service in registration information service

Service Name	Announcement Service	
Requirement	Inform	
Determining Stakeholder(s)	**Related Agents**	**Related Actors**
	Student	Service Consumer
	Advisor	Service Consumer, Service Operator
	Campus Online	Service provider, Service Registry
	Administrative Board	Service Certifier
	Registrar Office	Service Operator, Service Consumer,
Triggering Service (Event)	An event, an announcement and so on occurs in the system.	
Service ID	001	

Table 4.25 Course selection service in registration information service

Service Name	Course Selection Service	
Requirement	Course selection	
Determining Stakeholder(s)	**Related Agents**	**Related Actors**
	Student	Service consumer
	Campus online	Service provider, Service Registry
	Administrative board	Service Certifier
Triggering Service (Event)	Student entering to system	
Service ID	002	

Table 4.26 Error detection service in registration information service

Service Name	Error Detection Service	
Requirement	Error Detection	
Determining Stakeholder(s)	**Related Agents**	**Related Actors**
	Student	Service Consumer
	Campus online	Service provider, Service Registry
	Advisor	Service provider, service operator
	Registrar Office	Service Provider
	Administrative board	Service Certifier
Triggering Service (Event)	Course Selection service	
Service ID	003	

Table 4.27 Monitoring info service in registration information service

Service Name	Monitoring Info Service	
Requirement	Monitoring Information	
Determining Stakeholder(s)	**Related Agents**	**Related Actors**
	Student	Service Consumer
	Campus Online	Service Provider, Service Registry
	Advisor	Service Consumer
	Registrar Office	Service Consumer
	Administrative Board	Service Certifier, service consumer
Triggering Service (Event)	Request to monitor information about anything	
Service ID	004	

Table 4.28 Approval service in registration information service

Service Name	Approval Service	
Requirement	Approval mechanism	
Determining Stakeholder(s)	**Related Agents**	**Related Actors**
	Student	Service Consumer
	Advisor	Service Provider, Service Operator
	Campus Online	Service Registry
	Administrative Board	Service Certifier
Triggering Service (Event)	Selected courses are sent for approval	
Service ID	005	

Table 4.29 Course evaluation service in registration information service

Service Name	Course Evaluation Service	
Requirement	Course Evaluation	
Determining Stakeholder(s)	**Related Agents**	**Related Actors**
	Student, Instructor, Campus Online	Service Consumer
	Administrative Board	Service Provider, Service Registry, Service Certifier, Service Operator
Triggering Service (Event)	Beginning of semester, Course Cancellation, opening new section or course.	
Service ID	006	

In the below tables service description aspects are represented by columns. Each aspect of service description has two cells in the table, the first cell includes item name which is written with bold characters and the second cell includes explanation for each item.

Table 4.30 Announcement service specifications

Service Scope		Service Specification			
		Functional Specification		Non-Functional Specification	
Item	Explanation	Item	Explanation	Item	Explanation
Service Name	Announcement Service	**Service Interface**	Monitoring messages on the web page which is authenticated for related agent. Phone.	**Service policies**	The service scans registration transactions' results. If a message is created at the end of any registration transaction, the service looks at the relevant agent of created message and sends to relevant agent by two ways (e-mail and system message). The service waits confirm messages about receiving message. If the confirm message does not reach until a time, the service warns to registrar office' personnel for phone calling to inform relevant agent. If the agent receives the message or news, the service successfully finished. The registrar office or advisor could want to send a message to a student, so the service allows creating a message manually.
Service Type	Automated and non-automated	**Service Behavior**	The service provides informing for important news on the system.	**Price**	Determine by expert of domain.
Service Definition	If the system creates a message about any critical issue, the service sends to relevant agent (advisor, student, registrar office) automatically.	**Service Exceptions**	If every transaction of registration process is error free, the system does not create any message to inform, so the service does not occur. If the agent's e-mail address is wrong, if the agent does not enter the system and the agent's phone number is wrong, he/she cannot monitor or hear any news about his/her transactions.		
Service Goal	To inform relevant agent	**Service Operations**	Checks the every registration transaction, Sends created messages to relevant agents.		
Dependencies	Error Detection Service, Approval Service**,** Course Evaluation Service				

Table 4.31 Course selection service specifications

Service Scope		Service Specification			
		Functional Specification		Non-Functional Specification	
Item	Explanation	Item	Explanation	Item	Explanation
Service Name	Course Selection Service	**Service Interface**	Web page on the computer monitor.	**Service policies**	When the registration period starts if the students have course selection right, the opened courses are monitored on the student's account's webpage. The service allows selecting courses to student and the service allows adding courses to program. If one of the selected courses is cancelled by administrative board, a message is created by the service to sending relevant agents. If registrar office registers to a course section different from selected course section, a message is created by the service to sending relevant agents. At the end of course selection service if the system does not detect any error, the course selection service allows to send program for approval. When the announcement service informs a course cancellation in the approved program of a student, the service has to be available for re-registration period to relevant student.
Service Type	Automated	**Service Behavior**	The service provides course selection transaction in the registration process.	**Price**	Determine by expert of domain
Service Definition	When the system is opened to registration transaction if the student has course selection right, the service allows selecting opened courses to student.	**Service Exceptions**	If the system is not opened, the service is disabled. If the student does not have course selection right, the service is disabled. If the selected course has some prerequisites, the service is disabled for students who do not have requisites.		
Service Goal	Realized course selection transaction.	**Service Operations**	Checks the student's rights, Shows the opened courses, Adds selected courses to the program.		
Dependencies	Error Detection Service, Approval Service, Monitoring Info Service				

Table 4.32 Error detection service specifications

Service Scope		Service Specification			
		Functional Specification		Non-Functional Specification	
Item	Explanation	Item	Explanation	Item	Explanation
Service Name	Error Detection Service	**Service Interface**	Web page and computer screen	**Service policies**	When the course selection service occurs, the error detection service scans course selection service's results. If there is any error the error detection service creates an error message to sending relevant agent. After sending for approval as a result of course selection service, the advisor checks the program. If program is regular, an error message is created by advisor to sending relevant agents.
Service Type	Automated and Non-Automated	**Service Behavior**	The service provides error detection and error messages.	**Price**	Determine by expert of domain
Service Definition	The service checks the registration transactions' errors according to student's specifications and properties. At the end of the detection process if errors occur, a message is created relevant errors to sending relevant agents. The other error detection mechanism is realized by advisor manually.	**Service Exceptions**	If registration process is error free, any error does not occur and any error message is not created.		
Service Goal	To detect errors and creates a message about registration transactions.	**Service Operations**	Checks and compares the registration transactions and student specifications, Creates error messages to sending relevant agents (Advisors, students, registrar office). The program is checked by advisor after sending for approval. Creates a message by advisor if the program is not regular.		
Dependencies	Approval Service, Course Selection Service, Monitoring Info Service				

Table 4.33 Monitoring info service specifications

Service Scope		Service Specification			
		Functional Specification		Non-Functional Specification	
Item	Explanation	Item	Explanation	Item	Explanation
Service Name	Monitoring Info Service	**Service Interface**	Web page and computer screen	**Service policies**	When an agent (advisor, student, registrar office) logins the system. The monitoring service shows the agent's information (Historical information, registration transaction, taken courses, given courses etc.).
Service Type	Automated	**Service Behavior**	Shows information about registration transactions.	**Price**	Determine by expert of domain
Service Definition	When the agent is authenticated by the system, the information about relevant agent and his /her registration transaction is monitored on the account's webpage according to agents' rights.	**Service Exceptions**	If the agent is not authenticated or he/she does not login the system, the service does not work.		
Service Goal	Monitoring registration transactions' information and agent's information.	**Service Operations**	Checks agent's rights and agent's information. Shows information about registration transactions.		
Dependencies	Course Selection Service, Error Detection Service, Approval Service, Announcement Service, Course Evaluation Service.				

Table 4.34 Approval service specifications

Service Scope		Service Specification			
		Functional Specification		Non-Functional Specification	
Item	Explanation	Item	Explanation	Item	Explanation
Service Name	Approval Service	**Service Interface**	Web page and computer screen	**Service policies**	When the error detection is occurred by advisor manually, if the student's program error free, the advisor gives an approval for student's program.
Service Type	Automated	**Service Behavior**	Gives an approval to student's error free selected courses.	**Price**	Determine by expert of domain
Service Definition	When the student sends his/her program to advisor. Advisor checks the program is error free or not. If the program is error free advisor approves the student's program.	**Service Exceptions**	If the error detection service does not allow sending for approval, approval service is disabled. If the advisor does not give an approval for program, the service is disabled.		
Service Goal	Approves student's course program.	**Service Operations**	The system shows student's program to advisor. Advisor gives an approval to program.		
Dependencies	Course Selection Service, Error Detection Service, Announcement Service				

Table 4.35 Course evaluation service specifications

Service Scope		Service Specification			
		Functional Specification		Non-Functional Specification	
Item	Explanation	Item	Explanation	Item	Explanation
Service Name	Course Evaluation Service	**Service Interface**	Face to Face	**Service policies**	Before registration period, during registration period and after registration period the administrative board comes together. Open courses and the number of registered students are evaluated. Determines which courses should be closed and which courses are needed new sections.
Service Type	Non-Automated	**Service Behavior**	Determines course details, cancellation courses, opening courses and closing courses.	**Price**	Determine by expert of domain
Service Definition	Determines of opening courses, closing courses, courses details.	**Service Exceptions**	If the administrative board does not come together, the service cannot occur.		
Service Goal	Prepares the courses to registration process.	**Service Operations**	Takes the estimation of students who will attend courses to determine which courses should be opened before registration period. Determines which courses will open. Takes the registered students for a course and determines which courses will close.		
Dependencies	Course Selection Service, Announcement Service				

At the beginning of this section two real problematic cases are mentioned for the registration information system. The services which are proposed above are designed to solve each problematic case. The services policies cover all solutions of problems for proposed cases.

4.2.2.4 Service Composition

In the conceptual modeling method (SOCMM), service consumer requests a service with quality of service criteria that mentioned in chapter 3 or functional properties of services. When the requests meet the service's features according to requests of the service consumers, the relevant services automatically collaborate with each other. This collaborating process occurs at run time in the literature. The service oriented conceptual modeling method (SOCMM) advices that service descriptions, service policy, components of services, operation of services, service specifications and service functions are prepared in design time before run time (implementation level) to execution of composite services. The triggering service (event) section of service description and service policies could be used for service composition.

At the beginning of SOCMM the service registry has only simple services, after service publication composite services could be orchestrate by service composer according to service consumer's requests.

4.2.2.5 Service Monitoring

Service monitoring is a picture of overall relevant service. A service is designed before this step of conceptual modeling method so; this step shows us how appropriate is designed service, how strong is designed service, how composable is designed service etc. In other words service monitoring gives us an idea about relevant service; should be alive or not, should be developed or not or it should be enough or not. This step of SOCMM is realized after service publication or service implementation.

Chapter 5

Conclusion

The aim of this study is to propose a new service oriented conceptual modeling method for service oriented information system development. The third chapter includes the details of proposed service oriented conceptual modeling method (SOCMM). We mentioned the long standing problems (e.g. reusability, agility and model transformation) of the conventional modeling methods. Service orientation is one of the new approaches which are developed to solve problems. The major advantages of SOCMM are that (1) the steps of SOCMM occur quickly and dynamically, (2) the created services are reusable for the different information systems in the different domains, (3) the model transformation could be realized between the levels of abstraction.

To propose the conceptual modeling method we should have foundation knowledge about the information system development (ISD), the levels of abstraction, the conceptual modeling and the service orientation. To better understand the nature of ISD, scholars characterize ISD in terms of the levels of abstraction. ISD is usually characterized in terms of logical and conceptual levels to realize transition from informal representation (e.g. requirement identification and specification) to formal one (e.g. executable models such as programs). These levels are called levels of abstraction. Each level of abstraction has its own conceptual model(s).

A conceptual model describes actors, activities and entities involved in a service-oriented scenario and the relationships between them. Conceptual modeling comprises five elements which are (1) conceptual modeling context, (2) conceptual modeling method, (3) conceptual modeling grammar (language), (4) conceptual modeling script and (5) conceptual modeling quality. Especially the quality element

of the conceptual modeling is studied and the quality metrics in service context are produced at the end of this study.

Several approaches have been proposed to solve problems with the conventional methods. Under the assumption that service oriented approach brings solutions to some existing problems. Service oriented approach's core principles are effective model transformation among levels of abstraction, agility, reusability and communication between business and IT personnel [9]. This orientation can be adopted in the context of IS development, which is then called the service oriented information system (SOIS).

In the service oriented approach there is an additional level of abstraction which name is service level. We mentioned that each level of abstraction has its own conceptual model(s), so we should examine the position of our conceptual modeling method. Our conceptual modeling method is at the service level of abstraction. There have been the proposed conceptual modeling methods such as COSMO, OASIS and SeCSE in the service level of abstraction. When the proposed conceptual modeling methods are evaluated from the quality point of view and the guidance point of view, some conceptual modeling methods take the lower grades. The proposed conceptual modeling methods do not include any guidance and conceptual consistency. The evaluation framework about the service level conceptual modeling methods is proposed in early stages of this study.

If a model becomes the conceptual model, it has five elements which are mentioned above. The proposed modeling method (SOCMM) is not a fully conceptual model; it is a conceptual modeling method which is an element of conceptual modeling. It has also a conceptual modeling context which is service context. The SOCMM is needed to evaluate from the quality perspective and it should have a proper modeling language. To guide the processes of conceptual modeling method some steps are identified: (1) Scope of Domain for relevant SOIS (2) Determining Agents and Actors, (2a) Deciding IS Requirements (taken from business level), (3) Service Description (3a) Determining Service Specifications (3b) Determining Service Additional Information, (4) Service Composition, (5) Service Monitoring. Although SOCMM looks like similar to the water fall model, the second (determining agents

and actors) and the third (service description) step of SOCMM are developed simultaneously. There have been different types of service (Offered Service, Requested Service, Simple (Atomic) Service, Composite Service, Stateful Service, and Stateless Service.) in SOCMM.

Two cases which are healthcare and course registration information system are examined in this study to check viability of the proposed modeling method (SOCMM). Some tables which include the details and the properties of services are used to create products of the proposed conceptual modeling method (SOCMM).

5.1 Open Research Areas and Limitations

SOCMM is related to the service level of abstraction, so the conceptual models are needed to be developed for the other levels of abstraction in service context. SOCMM is the conceptual modeling method, it should has the conceptual modeling language and it should be evaluated from the quality element perspective to be a conceptual model.

The limitations of SOCMM are that: Associations of SOCMM should be examined in detail between levels of abstraction and aspects. It should be used in different industries to check viability.

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Curriculum Vitae

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