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Facilitators of modularity in healthcare services: An interpretive structural modeling approach

Shefali Srivastava[a]*

[a]*Christ Deemed to be University, Bangalore, India*

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ABSTRACT

The purpose of this paper is to perform structural analysis of facilitators of modular architecture in healthcare services by applying interpretive structural modeling (ISM). Inputs were taken from healthcare industry experts and academicians in identifying and understanding interdependencies among facilitators of modular architecture in healthcare services. Further these interdependencies are structured into a hierarchy in order to derive structural models to deliver useful insights for theory and practice. Using the ISM approach the facilitators of modularity in healthcare services were clustered according to their driving power and dependence power. Patient centricity is at the bottom level of the hierarchy implying highest driving power and requires higher attention to deliver quality care outcomes. Facilitators like value dense environment, knowledge and competence, goal alignment and le-agile strategies have medium driver and dependence powers. The study added insights to the theory of modular systems. Theauthors recognize that modularity helps in enhancing the patient centric orientation. The findings provide potentially important information to health service managers and providers, enabling them to understand the requisites of modular architecture. This is the first study exploring the relationships between facilitators of modularity in healthcare services. The study complements literature on service modularity with reference to specialized care unit of maternity services.

1. Introduction

In specialized hospital services, coordination of professionals and packaging of service components according to care plans might be a huge challenge. In order to mitigate this challenge the number of service components, such as individual treatments, is typically high, and responsibilities to develop and produce components have been divided between a multitude of autonomous professionals. Standardized health services help reduce information asymmetry, and standardized interfaces enhance patient flow (Vähätalo & Kallio, 2015). Therefore to streamline information flow and care coordination, and to reduce avoidable costs modularization and the modular service architecture can act as a facilitative catalyst and improve the overall efficiency of the services (Meyer *et al.,* 2007; Soffers *et al.,* 2014). Healthcare services are categorized into various specializations and one of the major specialized healthcare services which face the huge demand of uncertainty is the maternity services unit. On a global level it has been found that out of 10 pregnant women 3 women suffer fatal losses due to inefficient service delivery during their delivery time (Deloitte Global Healthcare Report, 2017). This inefficiency can be improvised by adapting the modular service approach for delivering quality care to patients. Modularization is expected to enhance flexibility (Bask *et al.,* 2010) by reducing complexity in fragmented systems. Baldwin and Clark (2006) define modularity as constructing complex products or processes from independently designed smaller subsystems that function together as a whole. This helps

* Corresponding author.

E-mail address: shefali.srivastava009@gmail.com (S. Srivastava)

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in clear division of tasks among the service providers. It enables the simplification of processes as there is a reduction of interdependencies among the interactions (Ethiraj & Levintahl, 2004).

Earlier studies disclose that modularity is a significant notion in the operations management domain (Sanchez & Mahoney, 1996). It has been discovered in other disciplines like biology (Bolker, 2000), mathematics (Edwards, 2007). Currently there has been an increasing trend in application of modularity in service provision, specifically areas like logistics (Bask *et al.,* 2010), shipping. There has been a significant evidence of modularization in healthcare (Meyer *et al.,* 2007; de Blok *et al.,* 2013; Soffers *et al.,* 2014; Vahatalo and Kallio, 2015; Silander *et al.,* 2017) but it remains scant in highly specialized hospital care like maternity services. Previous research has identified design aspects of service modularization such as customer involvement during the service process (Pekkarinen & Ulkuniemi, 2008), managing heterogeneity of customer requests (Rahikka *et al.,* 2011), standardization of interfaces (Chorpita *et al.,* 2005). These studies provide a good conceptual base to the theory of modularization. But a theory is better conceptualized when tested empirically through some validated relationships. Based on these insights the paper addresses following questions:

RQ1: What are the facilitators of modularity in healthcare services?
RQ2: How are these facilitators related to each other to manifest modular architecture in healthcare services?

The purpose of this paper is to identify and analyze the key facilitators of modularity in healthcare by establishing a proper hierarchy and contextual relationship of these key facilitators using interpretive structural modeling (ISM) and to classify these barriers using Matrice d' Impacts Croisés- Multiplication Appliquée á un Classement (MICMAC) analysis. The analysis would help the decision-makers, researchers and practitioners to prioritize the facilitators and provide strategies to implement the modular architecture in the healthcare service delivery system.

The remainder of the paper is organized as follows. First, the paper highlights the emerging literature pertaining to modularity in healthcare services and then provides a brief description of the facilitators. Next, research methodology is discussed including an overview to interpretive structural modeling (ISM) approach. Following this, the paper develops a structural model based on ISM techniques and classifies the facilitators in four different groups on the basis of their driving and dependence power. This is followed by discussion and conclusions.

2. Literature review

2.1 Modularity in healthcare services

Being a heterogeneous industry, healthcare services comprises specific service aspects which need varied attention from different stakeholders (Lillrank *et al.,* 2010, 2015). There have been an evidence of modularity in context of mental care (Bushe *et al.,* 2008; Chorpita *et al.,* 2005; Soffers *et al.,* 2014), elderly or home care (de Blok *et al.,* 2010, 2013, 2014), and in health insurance companies (Dorbecker *et al.,* 2013), hospital settings have also been considered (Bohmer, 2005; Kuntz & Vera, 2007; Meyer *et al.,* 2007). Thus, how the characteristics of specialized hospital services impact the modularization process and its outcomes should be well-thought-out. In general, specialized hospital service providers are required to treat all in need (Bohmer, 2005). Thus, providers cannot choose their patients in order to focus on service production on certain patient segments. This increases variation: both customized and standard services are required as patient needs differ between individuals and patient groups. This is especially evident in university hospitals where both secondary- and tertiary-level care is provided. Treated patients vary from those with standardized high-volume medical needs, such as patients for cataract surgery, to those with highly customized needs, for example, clinical-trial patients or patients with rare diseases. In addition, patients with complex conditions require services provided by various professionals, such as physicians from different specialties, nurses, physiotherapists, and nutritionists. Currently, different hospital healthcare services are often categorized under different medical specialties. In other words, services are divided into silos according to specialty departments (Vuorenkoski, 2008; Porter and Lee, 2013), which produce the different specialized services that patients require within the corresponding specialty (e.g. inpatient care in wards, outpatient care in the outpatient unit of the department). Thus, healthcare services are often fragmented between different departments and service providers, hindering common goals, and similar services may be produced under different specialties or healthcare units without collaboration in service production.

Studies in healthcare contexts provide major contributions to service modularity research by, for example, developing a theory of interfaces in service modularity (de Blok *et al.,* 2014), and by studying the use of personalization in modularity (de Blok *et al.,* 2013). Interfaces have twofold aims: variety or coherence (de Blok *et al.,* 2014). In addition, interfaces should be distinguished on two levels: the component level and the service package level (de Blok *et al.,* 2014). In modular service architecture, the coordinated co-operation of healthcare professionals is necessary to enhance continuity of care and the efficient use of the often fragmented independent service subunits. Seamless coupling is required in order to connect different modules in a way that supports variety (Chorpita *et al.,* 2005). Single care plans have been seen as a way to increase coherence in cases where patients require services from different healthcare professionals (Meyer *et al.,* 2007).

In this study, facilitators are defined as conditions that influence their target favorably, and these can be prerequisites or necessary conditions but not necessarily fully responsible causes of the resulting condition of the target. Service features such as immateriality, heterogeneity of demand, inseparability of service production and use, perishability, and customer participation in the co-creation of value (Grönroos, 1998; Lovelock & Gummesson, 2004; Parasuraman, 1998; Sampson & Froehle, 2006; Vargo & Lusch, 2004), may hinder modularity by challenging the clear definition of modules and the creation of well-defined interfaces. Due to their immaterial and process based nature, service modules are "softer" than physical product modules, i.e., service modules are more flexible and can often be varied ad hoc unless they are fully automated (Bask *et al.,* 2010).

As service production and use are both inseparable and perishable, and as customer needs are heterogeneous, service production requires flexibility, adaptability, and robustness. These conditions may constrain the standardization of service modules and interfaces. Nonetheless, earlier studies demonstrate that in service modularization, the standardization of interfaces with design and planning rules is possible (Baldwin & Clark, 2000; Liere *et al.,* 2004; Chorpita *et al.,* 2005; Pekkarinen & Ulkuniemi, 2008). The creation of a modular operating model includes the design of modular service architecture. In service production, the modularization of processes enables developing customized services from a limited number of modules. The modularization of services often requires the modularization of the organization as the clear division of work tasks to designated teams permits improvement within the independent modules. To succeed, modularization requires focused integration of the output of these individual teams through interfaces (Baldwin & Clark, 2000). Taking these cues the study tries to develop a model for modular healthcare service delivery. The facilitators of modularity are described in Table 1.

Table 1
Facilitators of modularity in healthcare services

SN	Facilitators of modularity in healthcare services	Author(s)
F1	Shared accountability	Sampson and Froehle, 2006; Silander *et al.,* 2017
F2	Perceived organizational support	de Blok *et al.,* 2010; Soffers *et al.,* 2014; Silander *et al.,* 2017
F3	Internal customer satisfaction	Meyer and DeTore, 1999; de Blok *et al.,* 2010; Silander *et al.,* 2017
F4	Organizational orientation	Berry and Bendapudi, 2007; de Blok *et al.,* 2010; Silander *et al.,* 2017.
F5	Patient-centricity	Chorpita, *et al.,* 2005; de Blok *et al.,* 2014; Silander *et al.,* 2017.
F6	Knowledge and competence	Berry and Bendapudi, 2007; Vahatalo and Kallio, 2015; Silander *et al.,* 2017.
F7	Le-agile strategies	Vahatalo, 2012; Vahatalo and Kallio, 2015.
F8	Employee relationships	Baldwin and Clark, 1997; Liere *et al.,* 2004; de Blok *et al.,* 2010.
F9	Sense of professionalism and collaboration	Chorpita, *et al.,* 2005; Silander *et al.,* 2017.
F10	Goal alignment	Baldwin and Clark, 1997; Pekkarinen and Ulkuniemi, 2008; Silander *et al.,* 2017
F11	Trust and commitment	Chorpita *et al.,* 2005; de Blok *et al.,* 2010 Lillrank *et al.,* 2010
F12	Mutual communication	Langois and Savage, 2001; Silander *et al.,* 2017.
F13	Flexibility	Soffers *et al.,* 2014; Vahatalo and Kallio, 2015; Brax e*t al.,* 2017
F14	Value dense environment	Meyer and DeTore, 1999; Soffers *et al.,* 2014; Vahatalo and Kallio, 2015.
F15	Technology integration	Bask *et al.,* 2010; de Blok *et al.,* 2010; Brax *et al.,* 2017
F16	Knowledge exchange	Vargo and Lusch, 2004; de Blok *et al.,* 2010; Vahatalo and Kallio, 2015
F17	High performance work environment	Chorpita *et al.,* 2005; Soffers *et al.,* 2014; Vahatalo and Kallio, 2015
F18	Cross functional teamwork	Chorpita *et al.,* 2005; Vahatalo, 2012; Silander *et al.,* 2017.

3. Methodology

The literature review was augmented by the use of online search engines like Science Direct, Emerald, Taylor and Francis, Google Scholar, Springer, etc. The literature selected for the study includes articles published in reputed SCI, SSCI and SCOPUS indexed journals. A total 28 facilitators of modularity in healthcare services were identified through the extensive literature review. A panel of experts checked the enablers for their relevance to the modular service architecture and also for their mutual exclusiveness. After the screening, a total 18 mutually exclusive enablers were selected for the research. Then, experts from the healthcare industry and academia were consulted to identify the relationship among the selected variables. Further, ISM technique is used to develop the structural model.

3.1 Development of structural relationship model for modularity in healthcare services

The study encompasses the real environment situations which strive to use multiple sources of evidence rather than relying on a single source (Yin, 2011). This contributes insights into existing concepts that may help to explain social phenomena. This part of the study uses an interpretivism approach for exploring the inter-relationship among the facilitators of modularity in healthcare services. The objective of this study was fulfilled through primary and secondary research. It was completed in three steps: a). identification of factors from literature; b). Validation of identified factors through empirical research; c). modeling and classification using ISM (Mahajan *et al.,* 2014).

Interpretive Structural Modeling (ISM)

ISM is a qualitative and interpretive method proposed by Warfield (1976) to evaluate complex socioeconomic systems. It provides solutions through structural mapping of interrelations of elements (Watson, 1978) and transforms unclear mental models into useful, well defined models (Ahuja *et al.,* 2009). In this technique a set of different directly and indirectly related elements are structured into a comprehensive systematic model. ISM is interpretive in the sense that the relationships are derived on the basis of judgment of experts in the area of the problem. It is structural as it leads to the formation of an overall structure of relationships between components of the system under study and it is modeling as the final output provides a visual representation of the system (Mahajan *et al.,* 2014). Its use is well documented in literature in areas like supply chain management, information technology, knowledge management and education. Numerous researchers used ISM modeling for various applications and they summarized its advantages and suitability as follows:

- Captures the complexities of real life problems and establishes the "leads to" relationships among the criteria (Raj and Shankar, 2007).
- Provides an ordered, directional framework for complex problems (Thakkar *et al.,* 2005).
- Higher ability for capturing dynamic complexity and gives decision makers a realistic picture of their situations and the variables involved (Ravi et al., 2005)
- ISM process transforms unclear, poorly articulated systems into visible and well defined models (Warfield, 1974).

Data collection

For this research, an exclusive list of 18 facilitators of modularity in healthcare services was used to develop a survey questionnaire. Questionnaire development and pretesting was done in accordance with the guidelines by Forza (2002). There is no consensus among researchers on the number of experts for ISM. The number varies from 8 to 42 (Thakkar *et al.,* 2008; Kumar *et al.,* 2014; Mahajan *et al.,* 2014). The experts were asked to compare each enabler against the other. After identifying the facilitators a survey was conducted among the eminent doctors and academicians for validation. Structured questionnaires, consisting of a list of facilitators identified, were designed. The respondents were required to rate them on a scale of 1-5 in the increasing order of importance. The reliability of each construct was tested by calculating the coefficient of reliability, Cronbach's alpha, using Statistical Package for Social Sciences (SPSS v23). The overall value came out to be 0.854 which is considered to be a good internal consistency. Based on the researcher's judgment, peer review and time and cost constraints, the questionnaires were administered personally as well as via email to a convenience sample of 88 academicians and eminent doctors across India out of which sixty five were received back and forty six responses were considered for research work and the rest were discarded due to incompletion. Table 2 gives a brief profile of respondents. Further the responses were tabulated in Excel. The mean, variance and rank on the basis of mean value has been shown in Table 3. A criterion of mean score greater than three was used for validation.

Table 2

Profile of the respondents for modularity survey (N= 46)

Respondent classification	Responses
Profile	Doctors–28 (61%); Academicians–18 (39%)
Age	30 to 40 years–19(41%); 40 to 50 years–15 (33%); 50 and above–12 (26%)
Gender	Male–27 (59%); Female–19 (41%)
Experience	>5 years–9 (20%); > 10 years–21 (46%); >15 years–16 (34%)
Region	North–17 (36%); South–12 (26%); East–3 (7%); West–3 (7%); Central–11 (24%)

Table 3

Mean and variance for the facilitators of the modularity in healthcare services

Facilitators	Mean	Standard Deviation	Variance	Rank based on Mean
1	3.650	0.834	0.695	XI
2	3.550	0.667	0.459	XV
3	3.950	0.714	0.510	III
4	3.775	0.619	0.384	VI
5	3.700	0.687	0.472	IX
6	3.650	0.662	0.438	XII
7	3.750	0.630	0.397	VII
8	3.625	0.667	0.446	XIII
9	3.975	0.733	0.538	II
10	3.875	0.822	0.676	V
11	3.475	0.598	0.358	XVII
12	3.525	0.716	0.512	XVI
13	3.425	0.594	0.353	XVIII
14	3.675	0.764	0.584	X
15	3.600	0.709	0.503	IV
16	3.950	0.815	0.614	XIV
17	4.175	0.813	0.661	I
18	3.750	0.707	0.500	VIII

Adjacent matrix or Structural Self Interaction Matrix (SSIM)

From the confirmed 18 challenges, a total of 153 comparisons were made. The phrase 'leads to' was used to describe the relationship between the enablers. After the contextual relationship was established by the responses, made by the experts, a structural self-interaction matrix (SSIM) was constructed. Table 4 elaborates the SSIM. For construction of the SSIM the responses of the experts were analyzed. Four variables were used to assign relationships between the enablers. These variables are: **V** variable i will lead to j: **A** variable j will lead to i: **X** variable i and j both lead to each other: **O**: variable i and j are unrelated. If more than 50 per cent of the responses for a particular relation were similar, the relation was finalized and if the responses were divided, it was taken to be "O" , that is the absence of a relation. A group discussion was then organized with another set of seven experts to deliberate on the identified relations. The final call was taken by the authors based on the responses and their observations, experience and judgment. Table 4 shows SSIM for facilitators of modularity in healthcare service.

Table 4
Structural self-interaction matrix (SSIM)

	j																
i	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2
1	O	O	O	A	V	A	O	V	O	A	A	V	V	V	V	O	V
2	A	A	O	O	V	O	V	O	O	O	A	V	V	V	V	A	
3	O	O	O	O	V	V	A	O	O	O	X	X	V	V	V		
4	O	O	O	A	V	O	A	A	O	O	O	V	V	V			
5	O	O	O	O	O	O	O	O	O	O	O	O	O				
6	A	A	O	O	V	O	O	O	V	O	A	A					
7	O	O	A	O	O	A	A	O	O	O	O						
8	O	O	V	O	V	O	O	A	V	O							
9	X	O	O	X	V	O	O	O	V								
10	O	O	O	A	O	O	O	O									
11	O	O	O	A	V	O	O										
12	O	V	O	O	V	O											
13	A	V	A	A	V												
14	O	O	O	O													
15	O	A	A														
16	O	O															
17	O																
18																	

Reachability matrix and level partitioning

Next, this SSIM is converted into the initial reachability matrix of 0s and 1s using the following set of rules:

- If the (i, j) entry in the SSIM in V, then the (i, j) entry in the reachability matrix will be 1 and the (j, i) entry will be 0.
- If the (i, j) entry in the SSIM in A, then the (i, j) entry in the reachability matrix will be 0 and the (j, i) entry will be 1.
- If the (i, j) entry in the SSIM in X, then the (i, j) entry in the reachability matrix will be 1 and the (j, i) entry will be 1.
- If the (i, j) entry in the SSIM in O, then the (i, j) entry in the reachability matrix will be 0 and the (j, i) entry will be 0.

In the Table 5, the initial reachability matrix is portrayed according to the rules given above apart from mentioning Driving Power (DP) and Dependence of each enabler. The driving power of an enabler is the total number of enablers (including itself) that this particular enabler may help to achieve and the dependence is the total number of enablers which may help to achieve it.

Table 5
Initial reachability matrix

	j																		
i	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	***Driving***
1	1	1	0	1	1	1	1	0	0	0	1	0	0	1	0	0	0	0	***8***
2	0	1	0	1	1	1	1	0	0	0	0	1	0	1	0	0	0	0	***7***
3	1	1	1	1	1	1	1	1	0	0	0	0	1	1	0	0	0	0	***10***
4	0	0	0	1	1	1	1	0	0	0	0	0	0	1	0	0	0	0	***5***
5	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	***1***
6	0	0	0	0	1	1	0	0	0	1	0	0	0	1	0	0	0	0	***4***
7	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	***3***
8	1	1	0	1	1	1	1	1	0	1	0	0	0	1	0	1	0	0	***10***
9	1	1	1	1	1	1	1	1	1	1	0	0	0	1	1	0	0	1	***13***
10	1	1	1	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0	***7***
11	0	1	1	1	1	1	1	1	1	1	1	0	0	1	0	0	0	0	***11***
12	1	0	1	1	1	1	1	1	1	1	1	1	0	1	0	0	1	0	***13***
13	1	1	0	1	1	1	1	1	1	1	1	1	1	1	0	0	1	0	***14***
14	0	0	0	0	1	0	1	0	0	1	0	0	0	1	0	0	0	0	***4***
15	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	0	0	***14***
16	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	0	0	***15***
17	1	1		1	1	1	1	1	1	1	1	0	0	1	1	1	1	0	***15***
18	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	***17***
Dependence	***11***	***12***	***9***	***14***	***18***	***15***	***16***	***9***	***6***	***12***	***8***	***6***	***5***	***15***	***5***	***4***	***4***	***2***	

The reachability matrix is decomposed to create structural models. This is an algorithm-based process which provides for the grouping of variables into different levels, depending upon their interrelationships (Ansari *et al.,* 2013). The reachability and antecedent sets for each enabler are obtained from the final reachability matrix as shown in Table 6. Depending on each enabler's driving power and dependence, they will be classified later into autonomous, dependent, linkage and independent metrics. The reachability set R (s_i) of the element s_i is the set of elements defined in the columns that contain 1 in row s_i. Similarly, the antecedent set A (s_i) of the element s_i is the set of elements defined in the rows that contain 1 in column s_i. The process of ISM methodology is completed in 9 iterations in this study. With each iteration of level partitioning, the intersection set of both the reachability set and the antecedent set is found. The element in this intersection set is the top-level element. This element does not let any other element succeed itself. Once this element is identified, it is separated from all the other elements. Then by the same process, the next level of elements is found. After all iterations were complete, the final level partitioning from first to final iteration was developed and the reachability matrix was checked for transitivity. The transitivity of relations is a basic assumption made in ISM which states that if a variable A is related to B and B is related to C, then A must necessarily be related to C. Table 6 shows the final reachability matrix.

Table 6
Level partitioning-final reachability matrix

SN	Factors	Reachability set	Antecedent set	Intersection set	Level
1	Shared accountability	1,2,4,5,6,7,11,14	1,3,8,9,10,12,13,15,16,17,18	1	**VIII**
2	Perceived organizational support	2,4,5,6,7,12,14	1,2,3,8,9,10,11,13,15, 16,17,18	2	**VII**
3	Internal customer satisfaction	1,3,4,5,6,7,8,1,14	3,9,10,11,12,15,16,17,18	3	**IX**
4	Organizational orientation	4,5,6,7,14	1,2,3,4,8,9,10,11,12,14,15,16,17,18	4	**V**
5	Patient centricity	5	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18	5	**I**
6	Knowledge and competence	5,6,10,14,	1,2,3,4,6,7,8,9,11,12,13,15,16,17,18	6	**IV**
7	Le-agile strategies	5,7	1,2,3,4,7,8,9,10,11,12,13,14,15,16,17,18	7	**II**
8	Employee relationships	4,5,6,8,10,14,16	3,8,9,11,12,13,15,17,18	8	**VII**
9	Sense of professionalism	5,6,9,10,14,15,18	9,11,12,13,16,17	9	**VII**
10	Goal alignment	5,10	6,8,9,10,11,12,13,14,15,16,17,18	10	**II**
11	Trust and commitment	4,5,6,7,11,14	1,11,12,13,15,16,17,18	11	**VI**
12	Mutual communication	5,6,10,12,14,17	2,12,13,15,16,18	12	**VI**
13	Flexibility	5,6,7,13,14,17	3,13,15,16,18	13	**VI**
14	Value dense environment	5,10,14	1,2,3,4,6,9,11,12,13,14,15,16,17,18	14	**III**
15	Technological integration	5,6,7,14,15	9,15,16,17,18	15	**V**
16	Knowledge exchange	5,6,7,14,15,16	8,16,17,18	16	**VI**
17	High performance work environment	5,6,7,14,17	12,13,17,18	17	**V**
18	Cross functional teamwork	5,6,7,14,17,18	9,18	18	**VI**

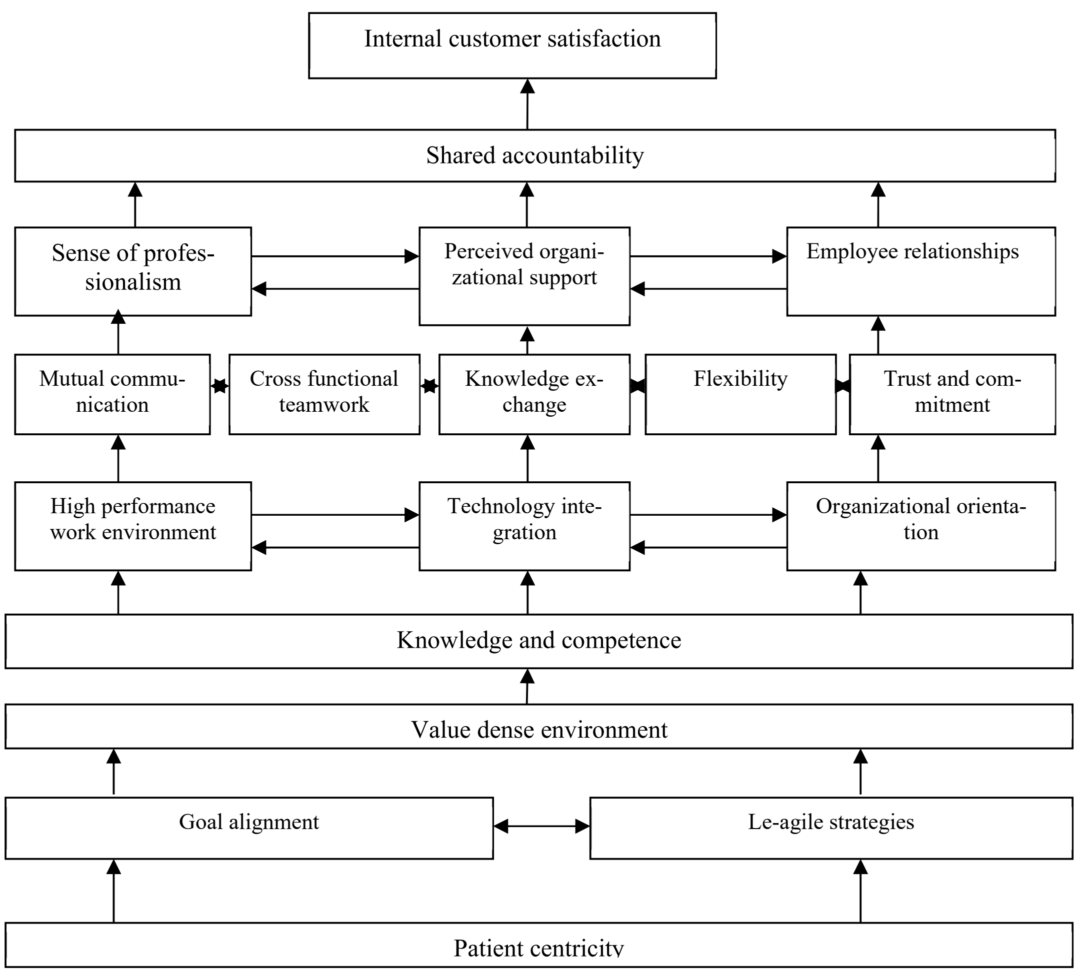

Fig. 1. ISM based model for facilitators of modularity in healthcare services

From the final reachability matrix the structural model is generated known as digraph. After removing the transitivity links and replacing the node numbers by statements, the ISM model is generated which has been shown in Fig. 1.

Matrice d'Impacts Croises Multiplication Appliqnce a un Classement (MICMAC) analysis

The objective of MICMAC analysis is to analyze the driving power and dependence power of the drivers under study (Mandal and Deshmukh, 1994). The MICMAC principle, also called cross impact matrix multiplication applied to classification, is based on multiplication properties of matrices (Thresh *et al.,* 2014). It is an indirect classification method to critically analyze the scope of each element.

In MICMAC analysis, as shown in Figure 6.3, the factors are divided into four clusters, namely, autonomous, dependent, linkage, and driver or independents. The drivers which have weak driving and dependence power occupy their place in Cluster I, which is called autonomous. These drivers are relatively disconnected from the system. Internal customer satisfaction comes out to be the autonomous variable. This reflects that it has weak driving and dependence power. The drivers which have low driving and high dependence power occupy their place in Cluster II, named as dependent driver. Organizational orientation, trust and commitment, mutual communication, flexibility, technological integration, knowledge exchange, high performance work environment and cross functional teamwork are called dependent drivers. Besides assigning high priority to these facilitators, the hospital administration should understand the dependence of these facilitators in achieving the modular architecture in healthcare services. In Cluster III, those drivers which have high driving and high dependence power occupy their place and are named as linkages. These drivers are unstable in the fact that any action on these will have an effect on others and also a feedback on themselves. Patient centricity, perceived organizational support, employee relationships and sense of professionalism comes under the cluster of linkage variables. The drivers which have strong driving and weak dependence power are called independent (dominant) drivers and come in Cluster IV. Shared accountability, knowledge and competence, le-agile strategies, goal alignment and value dense environment comes under the cluster of independent drivers.

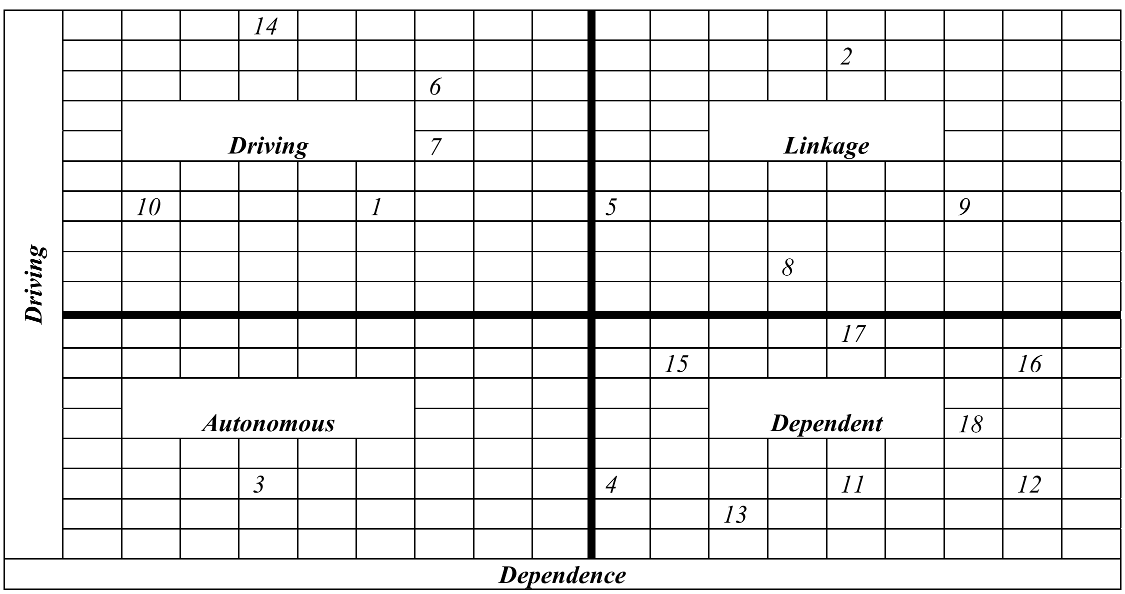

Fig. 2. Driving and dependence matrix

Autonomous:	Internal customer satisfaction
Dependent:	Organizational orientation, trust and commitment, mutual communication, flexibility, technological integration, knowledge exchange, high performance work environment and cross functional teamwork
Linkage:	Patient-centricity, perceived organizational support, employee relationships and sense of professionalism
Driving:	Shared accountability, knowledge and competence, le-agile strategies, goal alignment and value dense environment

4. Discussion

This paper focused on designing a structural framework for modular healthcare service delivery. For this, facilitators of modularity in healthcare services have been identified from the literature. The resulting model explains that to build a modular architecture in the process orientation of healthcare service delivery it is necessary to strengthen the facilitators of modularity. With the help of interpretive structural modeling the inter relationships among these facilitators was explored. It also resulted in giving hierarchical level to all the facilitators. Thus it can be said that modularity is the degree to which a system can be separated into components, the level of coupling between these components and the recombination of these components (Schilling, 2000). Elaborate discussion of the results is presented in the following section.

ISM based model (Fig. 1) clearly shows that the highest driving power lies with patient centricity, goal alignment, le-agile strategies and value dense environment respectively, so they are at the bottom of ISM hierarchy. This explains that modular architecture in healthcare should be designed keeping the needs and demands of the patient as the focal point. This patient centric orientation will help in clear division of tasks ensuring alignment of goals for delivering quality care. Patient centricity also paves the pathway for adopting le-agile strategies in the service delivery phenomena. Le-agile strategies ensure that delivery of care is timely and efficient. This also reflects that with higher patient centric orientation, better aligned goals and effective adoption of le-agile strategies imparts in creating an environment where value is co-created. Knowledge and competence also plays a crucial role in designing a modular architecture. A module will be designed on the basis of professionals' skill-set and medical competence. For instance if a module has to be designed for oncology departments then the professionals' working for that module need to be highly proficient in the delivery process for patients coming in that module. The next level incorporates a high performance work environment, technology integration and organizational orientation. Modularity is a concept that is developed by the organizations to facilitate the care delivery process. This will be strengthened when the organization provides a robust working environment for the service delivery process. Technology acts a catalyst in modularizing health services as it helps in creating a strong channel of information sharing and facilitates the process through waste of energy and resources. The sixth level in the structural model devised through ISM comprises mutual communication, cross functional teamwork, knowledge exchange, flexibility, and trust and commitment. These facilitators share the same level in the model as they all create a channel which helps in sharing information for patient centric care. With active knowledge exchange and mutual communication among the modules teamwork is strengthened and level of trust and commitment is enhanced. As the care providers in the module deal with heterogeneous needs of the patients, they need to work with a flexible approach for disseminating care related details. Next level incorporates facilitators that support modularity in enhancing relationships among the care providers. Employee relationships are built with a sense of professionalism and collaboration with which they work to deliver patient centric care. Perceived organizational support caters the need of employees by assuring that organizations design modules for well-being of their employees. Final two levels incorporate shared accountability and internal customer satisfaction respectively. Functioning of modules in healthcare will go efficiently if the care providers develop a sense of accountability for their work. This sense of responsibility will come when an employee, who is also the internal customer of the healthcare service delivery system, feels the sense of satisfaction for the support they receive from the organization. Internal customer satisfaction comes at the highest level of the structural model representing the maximum dependence.

Thus this study elucidated that to strengthen the modular architecture, for the processes of healthcare services, organizations need to work on these facilitators in accord with the demand and input heterogeneity of the system. Other empirical studies are needed to validate the developed relationships. Overall, the study is the first to explore the facilitators of modularity in healthcare services and the inter relationships among these facilitators in a form of structural model. This structural model is framed through interpretive structural modeling. Yet, to test the generalizability of the framework for creating a value driven patient centric modular service system in health services, further research is needed.

5. Implications

Theoretical implications

The present study contributes to service modularity literature by demonstrating how the facilitators in the design phase support modularization of services when inherent characteristics of the service cause inertia in the modularization process. The study identified 18 facilitators that enabled the designing of modular service architecture in specialized hospital services. These facilitators explain how a traditional integral service architecture based on highly customized service components and non-standardized interfaces between service providers is transformed into a modular service architecture. The findings are in line with earlier studies on design of service modularity, apart from the lesser role of patient involvement in this study. This can be explained by high information asymmetry between professionals and patients in specialized hospital services: the role of providers is highlighted both in design of service components and packaging of components according to patient needs. Increased efficiency and improved human resource management are highlighted as positive outcomes whereas negative outcomes are related to loss of ownership, the limited possibility of carrying for all patients, and lack of informal communication and relationships. These findings are new in specialized hospital services and they complement the existing general research on service modularity as they depict how positive outcomes from modularization may be moderated due to changes in roles of professions, or due to the limited ability to focus on service offerings. Similar findings of limited outcomes could potentially also be found in other professional or public services.

Managerial implications

The understanding and defining the scope of modularized services is crucial for success in the design phase and long-term outcomes. The study indicated that modularization is applicable in treatment phases of the patient process where several sequential or periodical standardized service components need to be delivered. Instead, care of rare diseases and delivery of non-routine services are more challenging to standardize. Therefore, managers should carefully examine positive and negative consequences of modularization per service, design the service architecture accordingly for each service, and leave the most complex and rare services outside modularization. Modularization changes the roles of professionals and personnel groups, and the changes have to be understood and managed in order to develop sustainable modularized service systems. In hospital services, physicians traditionally have autonomy to modify the content of service events and customize service packages according to their expertise. Although a modular operating model would streamline processes and increase efficiency, in the long-term, managers should consider how to maintain physicians' inherent motivation to develop services. In other words, the validity of the traditional organization of specialized hospital services into specialties and their outpatient clinics can be questioned. Multi-specialty modules and units are needed to achieve critical volume to utilize standardized service components. In secondary- and tertiary-care hospitals, an optimal organizational structure would be a mix of highly modularized service sub-systems and units that provide more integral and customized services to meet the needs of rare diseases and project type patient episodes

6. Conclusions

The study developed a structural framework by identifying and empirically validating the relationships between facilitators of modularity in healthcare service delivery in a specialized environment of maternity care units. Results reveal that modular architecture can be by building an environment which has coordinated and integrated efforts of service providers incorporated with enhanced organizational orientation. The study contributes to the modular systems theory by designing modular service architecture. The study provides practitioners to understand and define the scope of modularized services are crucial for success in delivering quality care to the patients. The study elucidated that modularization is applicable in treatment processes where several sequential mechanisms need to be incorporated. Maternity services were considered as the unit of analysis for the research. In such specialized services, a modular operating model would streamline processes and increase efficiency in the long term. The study focused on the service provider perspective. This limits the perspective of modularity. Future researchers should focus on a holistic perspective for developing modular architecture. The study might not have identified all the facilitators of modularity. This reduces the generalizability of the findings. Moreover the researchers only focused on one care unit at one single period of time. Further studies can explore the longitudinal effects of modularization.

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