Enhancing coordination in complex modular hospital care provision

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Abstract

The objective of our study was to analyse how modularity may support coordination of health care delivery in hospital care. Case research is conducted in a hospital, where patients with a complex condition, receive care in a multidisciplinary team. We included the perspective of the patients and service providers to align both interests. This study has demonstrated that modularity can be used to enhance coordination in health care delivery. This coordination can be achieved by interfaces, as they take care of the interaction between components and modules, both within and across organizations.

Keywords: Service modularity, Coordination, Interfaces

Introduction

Modularity promises to relieve problems of complexity in service systems, by its ability to enable efficient customization and responsiveness to individual requirements (Voss & Hsuan, 2009). In healthcare, the need for more patient-centred care has been acknowledged (Singer et al., 2011). However, at the same time health services need to be more efficient, which might hamper the provision of patient-centred care. Complexity in healthcare processes stems from the diversity of the components of the service in terms of activities, personnel, resources needed, organizational practices, patient complications and types of services (Meijboom et al., 2011). Healthcare modularity studies have been

carried out in areas such as elderly care (De Blok et al., 2010) and mental care (Eissens-van der Laan et al., 2016), but hospital contexts have been studied to a lesser extent.

In modular health services, adequate use of interfaces is important. Elements in health services can, or need to, be consumed at different points in time, and at different locations (Eissens et al., 2016). Moreover, coordinated co-operation of healthcare professionals is necessary to enhance coordination of care and the efficient use of the fragmented health services. Seamless coupling is required in order to connect different modules and professionals (Silander et al., 2017). Interfaces can be used as a means to streamline information flows and coordination of care, as they specify in detail how components, modules and providers will interact with each other (Voss & Hsuan, 2009; de Blok et al., 2014).

Little is known about how interfaces manifest themselves in a multi-provider context (Brax et al., 2017; Peters et al., forthcoming 2018). For effective treatment of patients with complex conditions, like Down Syndrome (DS), coordination of professionals and care provision might be challenging as this context is characterized by complementary and specialized services. These services somehow need to be arranged into an integrated whole, which becomes even more difficult when those services stem from autonomous organizations.

In order to understand healthcare modularity a literature review was performed. A generic framework is derived from this study in order to describe and analyze modular care provision with specific attention for the dimension of interfaces. Insights from this literature review were used in an exploratory case study on chronic care provision for DS children. This resulted in a single in-depth case study in a hospital in the Netherlands. The results of this study are discussed and improve our understanding of interfaces in complex modular care provision.

Theoretical background and framework

Modularity, which stems from operations management, is a concept that decomposes a system in parts that can be managed independently (Baldwin & Clark, 1997). The larger system is divided in smaller parts, which have a clearly defined function and interface. A modular composition of services may allow the configuration of services to fulfil customer needs as services can be selected from a predefined set of modules. Interfaces connect services and service providers, and enable the linkage of different modules and components (Silander et al., 2018). In recent years, the application of modularity in healthcare has gained attention because of its possibilities for cost reductions in combination with individualization; the concept has increasingly gained attention (Vähätalo, 2012).

Previous studies have shown some variety in the effects that modularity may deliver. Modularity may decrease information asymmetry between the patient and service provider (Vahatalo & Kallio, 2015), it allows for flexibility in settings that require standardisation (De Blok et al., 2014) and it enables the delivery of more flexible, yet structured, health services. Modularisation of health care services relates to the identified need for cooperation between health care service providers to improve the continuum of care and coordination of services (Silander et al., 2018). This coordination of services can be achieved by interfaces, as they take care of the interaction between components, how they fit together, and how they connect, interact, and communicate within the modular package.

Interfaces

Various interface types can be recognized in the service modularity literature (Peters et al., forthcoming 2018). Broekhuis et al. (2017) have made a distinction between functional interfaces and organizational interfaces. Functional interfaces focus on the connection and alignment between the different modules, while organizational interfaces focus on the coordination and interaction between service providers and between service providers and "customers" (Broekhuis et al., 2017). Furthermore, Spring and Santos (2014) have made a distinction between structural and procedural interfaces. The former type refers to the outcome dimension of service modules, whereas the latter type addresses the temporal nature of the service delivery and is related to the interaction between the service provider and the customer. Another distinction between various types of interfaces is made by De Blok et al. (2014), which made a distinction between four types of interfaces. Our study makes use of the conceptualization by De Blok et al. (2014), as they developed the most recent and comprehensive healthcare-specific typology in service modularity (Peters et al., forthcoming 2018).

The typology by De Blok et al. (2014) is based on two dimensions, interface *entities* and interface *aims*. The interface entities refer to the decomposition level – components and services providers – while the interface aims can either provide coherence or provide variance. The authors label the interfaces that create coherence as 'closed' interfaces, since they strive for standardization and unity (Peters et al., forthcoming 2018). The interfaces aiming at providing variety are called 'open' as they enable individualized adaptations for each customer. The interface entities stem from the analytical level at which they are in play: either on the component level or on the service provider level. Interfaces between components support the *customer* flow from component to component and interfaces between service providers affect *information* flow in the service package as a whole (De Blok et al., 2014). Based on those insights, four different types of interfaces can be distinguished: closed-customer (C-C), open-customer (O-C), open-information (O-I), and closed-information (C-I) interfaces.

Singer et al. (2011) argue that the coordination of care and services often seeks to achieve automation, efficiency, coherence, and simplicity. This coordination of care could be achieved by the previously mentioned interfaces. C-I interfaces are interfaces that support coherence and unity among people (De Blok, 2010), while C-C interfaces support coherence in a service package among components (De Blok, 2010). Both types of interfaces diminish the amount of information exchanges needed, since the interactions between people or components can be predicted via these types of interfaces (De Blok, 2010). Based on the ability of both interface types to provide predictability and coherence, we assume that these interfaces can support coordination, with a focus on simplicity and efficiency can be recognized. O-I interfaces can support coordination by recognizing (changes in) patients' needs and requirements. O-C interfaces could build on this by supporting the adaptation process, as this interfaces provide a structure that enables the (re) combination of component variations (De Blok, 2010). For expect that these two types of interfaces can enhance coordination, based on their ability to account for guiding changes in the overall service delivery.

Methodology

This study aimed to improve the understanding of interfaces by focusing on relationships in the provision of modular care provision for children with DS. A case study research design was chosen since this method is recommended as the most appropriate when, among others, contextual conditions are believed to be highly pertinent to the phenomenon of study (Eisenhardt 1989; Yin, 2003). The case study research was

conducted in the Netherlands, in the field of chronic care provision for DS children. The multidisciplinary team, providing DS care, of the Máxima Medical Centre (MMC) was chosen, as the researchers had access to this team. The MMC is a general hospital in the Netherlands (MMC, 2017). During the childhood of individuals with DS, their healthcare is coordinated by a coordinator of a specialized multidisciplinary so-called Downteam. In the Downteams, the pediatrician is the coordinator and collaborates with different medical, paramedical and non-medical specialists, doctors for the mentally handicapped, and the Dutch foundation for Down syndrome (van den Driessen-Mareeuw et al., 2017). During a visit to the Downteam, the DS child subsequently visits various specialists that are members of the Downteam, within one given part of the day.

By means of purposive sampling we conducted 15 interviews with parents of children with DS (N = 4) and members (medical, paramedical and non-medical specialists) of a Downteam (N = 11). Interviews were semi-structured, lasted approximately one hour and questions were based on (healthcare) modularity literature. Because the interviewees were not familiar with the vocabulary of modularity, questions were adapted to topics relevant for care provision by Downteams. The study was approved by the Ethics Review Board of Tilburg University. To enable triangulation of information, the data was collected from multiple sources within the hospital: 15 semi-structured interviews, 6 observations and documentation.

Since the interviewees did not address their practices in modularity terms, transcripts were interpreted in modular terms (Soffers et al., 2014). The gathered data were analyzed using the methodology developed by Miles and Huberman (1994) and consists of three concurrent flows of activities: 1) data reduction; 2) data display, and 3) drawing and verifying conclusions. By making use of this methodology we provided rigor in our research, as we are open to the data and thorough in our data collection.

Findings

From a modular perspective, packages, modules, and components can be distinguished with regard to the services offered by the Downteam. Figure 1 shows an example of a modular package that can be offered.

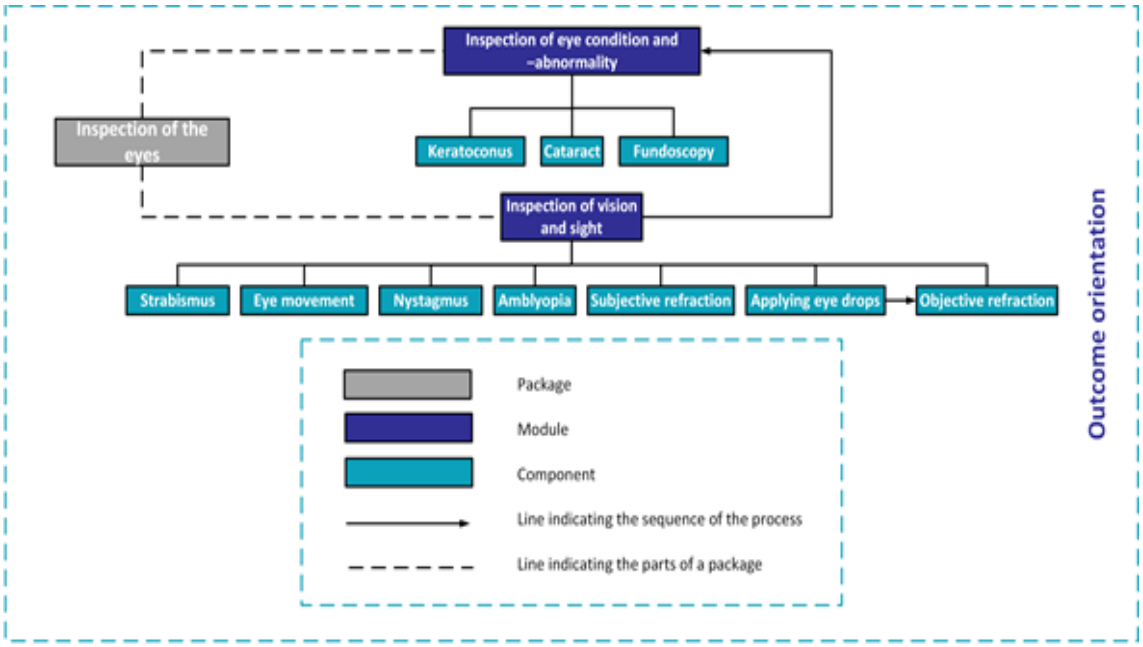

Figure 1 – Example of package, modules, components and interfaces

Modules, components, and a service package are recognized. Regarding the latter element, a package, *inspection of the eyes*, is recognized. Moreover, based on the findings, two modules regarding this package were perceived: *inspection of eye condition and –abnormality*, which is performed by the ophthalmologist, and *inspection of vision and sight*, which is performed by the orthoptist. Lastly, several components have also been identified such as *strabismus, cataract,* and *nystagmus*. Within the care provision for DS children, a variety of interfaces could be identified. We will elaborate on those interfaces in the next sections.

Open-information interfaces
O-I interfaces offer a structure so that people are brought together (De Blok, 2010). In the current state, O-I interfaces are recognized on three levels: between service providers within the same organization, between service providers across organization boundaries, and between service providers and parents. The former level of O-I interfaces is created via, for instance, face-to-face-contact, a letter, or by means of the electronic patient file to which employees of the hospital have access to. This file is used to make information exchanges between the various disciplines possible and is always available during a consultation. The service providers who do not have access to this electronic patient file, receive information of the other service providers during the multidisciplinary meeting, in which the gathered information of all the disciplines involved is discussed. In addition to the interfaces within the Downteam, an O-I interface is also identified between the pediatrician of the MMC and the intellectual disability physician of a long-term healthcare organization.

Closed-information interfaces
C-I interfaces ensure coherence between healthcare professionals by means of standardized arrangements, which reduce the amount of information to be exchanged (De Blok, 2010). C-I-interfaces are recognized in the current state by means of, for instance, work schedules and the division of work. Related to the latter, the amount of information to be exchanged remains limited due to the recognized division of work, which is created by the fact that every healthcare professional of the Downteam has their own expertise: *"The physical examination is mainly focused on the motor skills and the mobility of the joints. This expertise is really linked to my discipline" [Physiotherapist]*. Furthermore, a work schedule has also been recognized, since the process is scheduled in such a way that, for instance, first the orthoptist is visited and that during the break, which is caused by applying drops in the eyes of the patient, an appointment is scheduled with the ENT-doctor, in order to realize a continuous flow of the patient.

Open-customer interfaces
O-C interfaces provide a structure that enables the (re)configuration of components (De Blok, 2010). Based on the findings, a structure that contains modules and components to choose from, is recognized at almost every discipline. This structure is recognized by means of the protocols that are used by most service providers: "*I use various protocols, such as: malnutrition, lactose intolerance, celiac disease, intestinal problems and growth retardation" [Dietician].* Although all the protocols are standardized, some freedom of (re)configuration is recognized due to the consideration of certain needs, ages, or illnesses of patients: "*There are various protocols; however, from all these protocols, I focus on the protocol that matches the needs of the patient" [Dietician].*

Closed-customer interfaces

C-C interfaces enable the arrangement of components, to ensure that components work together in a predictable way (De Blok, 2010). The findings show that planning rules and planning schemes can be recognized. Planning rules are recognized due to the strict sequence into which some components need to be carried out, for instance by the orthoptist. The recognized planning rule ensures that the components work together in a predictable way. Moreover, some preferences have been recognized linked to the sequence in which service providers are visited by patients. The pediatrician, for instance, needs to consider the weight and length before the patient visits the dietician. The planning scheme, which regulated the sequence wherein healthcare professionals of the Downteam are visited, makes it possible that the components, with regard to the determination of the *length and weight*, are known before the patient visits the dietician. Hence, an arrangement of components to ensure that the components work together in a predictable way is recognized by means of, among other things, planning rules and a planning scheme.

Coordination between professionals within the same organization

Coordination between professionals within the same organization refers to the interaction between service providers in order to deliver consistent and informed patient care (Singer et al., 2011). The data showed that the coordination between the service providers within the same organization is arranged by means of all the four interfaces types mentioned by De Blok et al. (2014). O-I interfaces are, for instance, recognized and create a structure that brings the healthcare professionals of the Downteam together. Moreover, C-I interfaces were also recognized in order to deliver consistent care and to reduce the amount of information that needs to be exchanged between the service providers by means of, for instance, an electronic patient file.

Besides the fact that the electronic patient file can be seen as an O-I interface, it can be seen as a C-I interface as well. For instance, the pediatrician of the Downteam records the length and the weight of the patient in the electronic patient file. As a result, the dietician, who has access to the electronic patient file, knows the length and the weight of the patient without interacting with the pediatrician: *"I literally need the length and weight of the pediatrician's consultation. I search the system for the identified length and weight of a patient" [Dietician].* Since the pediatrician is aware of the fact that the dietician needs the length and weight for her consultation, he directly enters the results of his consultation into the electronic patient file when the results are known. Hence, in this example, the electronic patient file also makes a consistent and predictable interaction between the pediatrician and the dietician possible, without the need of a direct interaction between the pediatrician and the dietician.

Although process oriented interfaces between professionals are recognized, other interaction forms on an outcome level can also be recognized in order to deliver consistent and informed patient care. For instance, the orthoptist and ophthalmologist try to base their work on the overall national DS guideline. With regard to this example, planning rules were recognized to ensure that the interaction between the components, such as the input-output sequence is managed in a proper way: *"When a child is in the age category with a higher chance of cataract, I have to put the eye drops in the eyes of the child during my consultation. This is because the ophthalmologist can see the inside of the eyes better when eye drops are used" [Orthoptist]*.

Coordination between professionals from different organizations

Coordination between professionals from different organizations is recognized by means of O-I interfaces. This retrieval and exchange of information is recognized via face-to-face contact, a letter, mail, or a phone call. Face-to-face contact is applied between the pediatrician of the MMC and the intellectual disability physician of Severinus, when a child is transferred from the Downteam of the MMC towards the Downteam of Severinus. The exchange by means of a letter is particularly based on the extent to which parents transfer the letter, with all the findings from the healthcare specialists of the Downteam, to the service providers from whom they receive primary care. Finally, the latter two interactions forms are only used in exceptional cases when for instance particularities have been found: *"The report in the letter is always in accordance with our screening protocol. Parents can give this report to the primary care physiotherapist whom they visit. However, if I find any particularities, I will contact the primary care physiotherapist by mail or phone" [Physiotherapist]*.

Discussion

Although the study by Broekhuis et al. (2017) mainly focused on the use of modularity principles for the (re) design of an elderly care environment, this study found that a modular perspective could also be applied in the context for patients with complex chronic conditions. Moreover, while Broekhuis et al. (2017) mainly underlined the principles from the perspective of the service provider, the empirical part of this study showed that the involvement of "customers" could also be valuable for the recognition of the various modularity principles and the development of the service provision.

Regarding the third modularity principle, the four interface types mentioned by De Blok et al. (2014) were perceived, although O-C and C-C interfaces were not clearly categorized and documented by the case company. This also emerged during the case study by Soffers et al. (2014). Moreover, it was found that the interface entities, mentioned by De Blok et al. (2014), could be linked to the orientation types addressed by Eissens-van der Laan et al. (2016). This finding was based on the recognition that interfaces on a people level have a strong focus on "how" the service needs to be delivered, whereas interfaces on a component level have a strong focus on "what" kind of service has to be delivered (Eissens-van der Laan et al., 2016). As a result, this study defined interfaces on a people level as process oriented interfaces, and interfaces on a component level as outcome oriented interfaces. The relationship between these two concepts has not yet been addressed by other studies.

With regard to the O-I interfaces, these interfaces were recognized on three levels: 1) between service providers within the same organization, 2) between service providers and patients, and 3) between service providers across organizational boundaries. The latter level has not yet been recognized during other studies, such as by De Blok et al. (2014) and Soffers et al. (2014). This difference could be explained since this research focused on patients with complex chronic conditions. These patients need various (para) medical service providers, who all have their own specialism. Because of this specialism, these service providers are often divided over different departments or organizations (Silander et al., 2017). For example, although the audiology assistant of the Downteam is needed for the care that is provided by the Downteam, she is not an employee of the hospital. As a result, multiple healthcare professionals from various organizations cover the overall care provision, which creates a situation in which O-I interfaces were also recognized across organizational boundaries. Based on these findings, we assume that interfaces can enhance coordination on two levels: coordination between professionals within the same organization and coordination between professionals from different organizations. This

classification is, in another stream of literature, also known as inter- and intra-organizational relationships (Cropper et al., 2008). We developed a typology (See Table 1), building on the work of de Blok et al. (2014), where we identified the interacting orientation of interfaces i.e. within and across organizations. We differentiate from de Blok et al. (2014), since they discovered the interacting aims i.e. variety and coherence of interfaces. Following this, we identified four interface types: intra-organizational outcome (IAO), intra-organizational process (IAP), inter-organizational outcome (IEO) and inter-organizational process (IEP) interfaces.

Table 1 – Conceptualization of interfaces

	Interacting entities		
		Between components	*Between service providers*
	Within	IAO-interface *e.g. planning scheme*	IAP-interface *e.g. multidisciplinary discussion*
	Across	IEO-interface *e.g. referral*	IEP-interface *e.g. interoperable medical record*

Furthermore, the findings made clear that the coordination between professionals is arranged by means of various interfaces. However, what emerged from the data is that before creating interfaces that support coherence, C-C and C-I interfaces, the variety interfaces, O-C and O-I-interfaces, are needed in order to provide a structure that brings the involved service providers, the modules, and components together. With regard to, for instance, the lacking documented O-C interfaces, the existing protocols, interviews and observations, created the possibility to develop an O-C interface. Based on this structure of modules and components, it became apparent that some components have to be executed in a specific sequence. Regarding this finding, the claim has been made that O-C interfaces provide the basis for C-C interfaces. This assumption is based on the empirical result that after the documentation of the O-C interface, planning rules with regard to the sequence in which the components needs to be delivered, were easier to capture. Although this sequence has not been fully explored in other studies, a slight resemblance to the study of De Blok (2010) has been found, where open interfaces precede closed interfaces with regard to the (re)configuration of a service package. Overall, a clear structure seems a prerequisite before coherency can be created.

Moreover, regarding the open interfaces, it is suggested that these can be supported by means of modules and components, since these elements provide a structure where the (re)combination of modules and components involved can be enabled (O-C interface) or discussed (O-I interface). As a result, an additional link between modularity and coordination has been identified, since both interfaces are used as a basis to ultimately make the coordination between professionals possible. Summarizing, it seems that the four interface types and the possibility to decompose a service into modules and components are preconditions for the creation of an optimal coordination between professionals within the same organization and between professionals from different organizations.

Therefore, both information-flow and customer-flow interfaces should be in place to increase coordination and cooperation of healthcare professionals to enhance continuity of care (Silander et al., 2017). These interfaces are essential in ensuring the right patient receives the right care at the right time. A more tentative conclusion is that, in

multidisciplinary settings, modularity could stimulate discussion about achieving patient-centeredness through both types of interfaces.

Contribution

From a theoretical point of view, our study contributes to the service modularity literature, since this study is one of the first studies that investigated the concept of service modularity for a heterogeneous population with complex chronic conditions (DS). Secondly, the interface types addressed by De Blok et al. (2014) have been further investigated during this study. Although De Blok et al. (2014) and Soffers et al. (2014) investigated the applicability of the different types of interfaces in a care environment; these types were further investigated in a cure environment that focuses on patients with complex chronic conditions (DS). Since interfaces during this study were found within and across organizational boundaries, this research showed that external interfaces in modular care provision could be recognized as well, where secure- and legal interfaces seem to be important preconditions. Moreover, connecting the interface types of de Blok et al. (2014) with the orientation types mentioned by Broekhuis et al. (2017), we found that the interacting entities could also be distinguished by means of a process- and outcome orientation. Thirdly, this is one of the first studies that contribute to the knowledge on how service modularity can improve the level of coordination within a multidisciplinary team that focus on patients with complex chronic conditions. Furthermore, due to the focus of this research on patients with a complex chronic condition, this research can also form the basis for the applicability of the findings within other (multidisciplinary) teams that focus on complex (chronic) conditions

From a managerial point of view, the results of our study will lead to recommendations for the creation and improvement of structures that enable an overview of all possible activities than can be carried out on the one hand and structures that enable the retrieval and exchange of information on the other hand. Regarding the latter structure, it is recommended to create well-arranged communication lines between all the service providers involved. Moreover, in order to improve the service providers' familiarity with the patients' treatment history, it is recommended to focus on the delivery of the service by the same dedicated service provider.

Conclusion

The findings of our in-depth case study showed that service modularity could drive coordination within the multidisciplinary setting of modular care provision for children with DS. Improvements can be achieved by means of the creation and further development of interfaces at both a process- and an outcome oriented level. Linked to these levels, it has been established that open interfaces are a prerequisite for the creation of coherence interfaces, in which the former type can be supported by means of the recognized modules and components. This is necessary in order to provide a structure that enables the (re) configuration of service packages. Furthermore, Consistent with health service literature, we show that coordination of care takes place at the level of components and service providers. Where de Blok et al. (2014) identified the interacting aims of interfaces, we provide more insight into the interacting orientation of interfaces, i.e. within and across organizations. In addition, we identified four new interface types. Concluding, in the context of services that operate in a complicated network of various stakeholders (e.g. construction services, health services), these interfaces become even more important because of the fragmented and multi-faceted structure of those services.

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