Discovering multilayered triads within a geriatric healthcare service ecosystem to steer innovation

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ABSTRACT,
The Covid-19 pandemic revealed problem areas in healthcare ecosystems around the world, also in the Netherlands where serious concerns about the aging population lead to doubts related to the future sustainability of the Dutch healthcare system. The importance of accessible healthcare services will keep rising with the increase of elderly citizens, especially within rural areas that are not easily traveled. This research visualized the existing healthcare ecosystem in Gelderland-Midden by coding fifteen interviews with relevant actors in the geriatric healthcare industry according to the ARA model, which resulted in an overview of a network consisting of thirty-eight interconnected actors. Three online-platform related solutions based on resources were proposed by an online platform provider: 'Match' that enables the user to search and schedule an appointment with the providers with the best-matching clinical expertise and the lowest waiting times. 'Connect' that enables the users to securely exchange data such as, health records. And 'coordinate' that helps healthcare teams to collaborate effectively and to deliver the right care at the right place, using a real-time communication platform. These solutions are combined with the different resource ties within the elven found multilayered triads giving an impression of the impact that each solution will have once implemented. This research provides a recommendation based on this impact to reveal the solution where the amount of effort spend would yield the best results. This research can aid the implementation of the three previously mentioned online-platform based solutions to increase the sustainability of the geriatric healthcare ecosystem in Gelderland-Midden.

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1. INTRODUCTION

The population of the Netherlands has gradually been aging since the 1950s with the population group aged between sixty-five and eighty more than doubling from 7% in 1950 to 15% in 2021 and an overall increase of the percentage of elderly citizens (Appendix 1). Which resulted in the expectation of age-based diseases, such as dementia, to increase by more than 200% from the year 2015 to the year 2040, which will increase the pressure on the Dutch healthcare industry further ("Cijfers en feiten ouderen in Nederland", 2022). Raising doubts related to the sustainability of the current Dutch healthcare system in the future.

A large EU project, aims to solve the healthcare problem by creating a service marketplace which "will connect the ecosystem of potential end-users and service providers in rural areas, delivering a broad spectrum of services while boosting economic growth and improving citizens' quality of life." Their focus is on rural areas in four countries; Sweden, Croatia, Spain and the Netherlands ("Homepage - dRural", 2022). In the Netherlands their goal is "developing a multisided e-health platform to enhance the accessibility of and coordination across care, cure, and prevention" within rural areas (Sahhar, von Raesfeld & Nieuwenhuis, 2022). These enhancements can help the Netherlands healthcare ecosystem to cope with the increasing population ("Gelderland Midden", 2022). This thesis focuses on the region 'Midden-Gelderland' of the province 'Gelderland' in the Netherlands where a big hospital in Gelderland-Midden, online platform provider (OPP), care innovation network, a municipality in Gelderland-Midden and Municipal Welfare foundations (MWF) try to make healthcare more accessible and affordable (pact.care, 2022).

Gelderland (Midden-Gelderland) is a good representation of the health care related struggles that the Netherlands will be facing in the future due to their similar percentages of elderly citizens on the total population (Appendix 2) as well as the many rural areas within Gelderland that can limit the accessibility of healthcare services for the elderly citizens.

The online platform provider assists the European project in Midden-Gelderland by offering three online-platform based solutions; match, connect and coordinate. This research aims to aid the service development of the geriatric healthcare service ecosystem in Gelderland-Midden, by determining the most effective of the three OPP solutions based on the number of matches between the multilayered triads and these solutions.

The ARA model (a framework used to operationalize relationships and interdepencies within an ecosystem based on three layers) as presented by Håkansson & Snehota (1995), Escher & Brzustewicz (2020) and Kavolevskaya, Holmen, Kaloudis & Pedersen (2021) will aid the description of the geriatric healthcare ecosystem network. The triad theory and subsequent multilayered triad theory stated by Siltaloppi & Vargo (2017), Håkansson & Gadde (2019) and Kavolevskaya et al. (2021), will give form to the described relationships within the network by highlighting relationships between three connected actors enabling the matching of solutions and multilayered triads. Resulting in the following research question:

To what extent can embedded multilayered triads contribute to the service development within the service ecosystem of geriatric healthcare in Gelderland-Midden?

In order to answer the research question multiple sub questions were created:

1. *How does the existing literature describe service ecosystems?*
2. *How can the ARA model describe the different actor relationships within a network?*
3. *To what extent can the Multilayered triad theory elaborate on the nature of the actor relationships within a network?*

All of the afore mentioned sub-questions are answered in theoretical framework (chapter two) by using existing literature on the respective subjects. The research method will be described in the methodology (chapter three). After which the geriatric healthcare ecosystem will be displayed in the form of a mapped network followed by descriptions of the found multilayered layered triads and the number of matches between those triads and the OPP solutions (chapter four). These findings will be used to answer the research question and make a recommendation for future service development within the geriatric health care ecosystem (chapter five).

The research within this paper uses the ARA model to uncover different actor relationships within the geriatric healthcare ecosystem network. Revealing the existing network and allowing a close up of the different triads that are imbedded within this network. These triads are portrayed in a multilayered triad format that enables the matching of the OPP solutions with the triads to see which of the three solutions would have the biggest impact on the ecosystem as a whole. These findings will result in a recommendation for the online platform provider to focus their efforts on the most influential solutions for the benefit of the ecosystem and thus the European project.

2. THEORETICAL FRAMEWORK

The following sub-chapters will address the main concepts of this research:

2.1 Service Ecosystems

The first mainstream acknowledgement of service ecosystems was in the form of the book: Service-Dominant Logic: Premises, Perspectives, Possibilities by Lusch & Vargo published in 2014 (Edvardsson & Tronvoll, 2021). Which presented to following definition of service ecosystems: "relatively self-contained, self-adjusting system of resource-integrating actors connected by shared institutional arrangements and mutual value creation through service exchange" (Lusch & Vargo, 2014, p.11).

Another definition was proposed by Frow et al. in 2019, which was adopted in 2022 by McColl-Kennedy, "Service ecosystems are relatively self-contained, self-adjusting systems where actors integrate resources for mutual value creation through activities and interactions." (McColl-Kennedy et al., 2022, p. 1). These definitions are relatively similar, and this seems to be the case for a lot of papers on this topic. It is evident that the definition of Frow et al. (2019) is also inspired by the definition of Lusch and Vargo (2014). Which is no surprise since Vargo & Lusch are referenced in the reference list of Frow et al. The relevance of this literature can be found by looking at the number of citations that their book has on Scopus.com, having 544 citations, with 45 of these citations coming from 2022, proving the influence of this work and the relevance in current times ("Citations of Service-dominant logic: Premises, perspectives, possibilities Lusch R.F., Vargo S.L.", 2023).

Another network based theory is the socio-technical system theory which is focused on "tools and machines that convert inputs into outputs by considering interrelated social and technical aspects" (Münch, Marx, Benz, Hartmann & Matzner, 2022, p. 3). This theory adopts part of the social interactions within a network with a focus on machinery and machine processes.

The third network based theory is the paradox theory which focuses on "contradictory yet interrelated elements (dualities) that exist simultaneously and persist over time; such elements seem logical when considered in isolation, but irrational, inconsistent, and absurd when juxtaposed" (Galvani & Bocconcelli, 2021, p. 2). This research is focused on how to address the problems that occur when a paradox appears.

The choice for service ecosystem theory related literature is based on the importance of resource-integrating actors, their connections and how mutual value can be created between these actors through activities and interactions. This previously mentioned actor-based focus is shared in this paper, making the service ecosystem theory a great fit for the research that will be conducted. Based on the matching of the three solutions with the resource ties between two actors.

2.2 ARA Model

The Activities-Resources-Actors (ARA) Model was developed by Håkansson and Snehota in 1995 and "is considered to be a useful basic framework for researchers attempting to operationalize business-to-business relationships and study the interdepencies between a company and its partners" (Escher & Brzustewicz, 2020, p. 4).

In their paper, Kavolevskaya et al (2021), elaborate more on the ARA Model by stating that this model is a good tool for studying the properties of the actors' relations. Since it "suggests that the substance of a business relationship consists of three layers – activity links, resource ties and actor bonds, thus allowing us to study each relationship in detail" (Kavolevskaya et al., 2021, p. 2). The activity links are the activities that link the actors together, the resource ties are the different resources needed by the actors to partake in the activity links and the actor bonds revere to interconnected entities (buyer, supplier, customer, etc.) with their own identity.

Furthermore, "The ARA framework highlights the role of actors as interconnected nodes in the network, with their own identity activities as they are implemented by actors and resources as they are activated and combined in an interdependent manner." (Fortezza et al., 2021, p. 2). This description seems a lot like the one provided by Kavolevskaya et al. which is explained by looking at the references of both papers where multiple entries of Håkansson and associates can be found.

The ARA model's focus on relationships makes it a great model to adopt in this research that is based on the different relationships within the geriatric healthcare ecosystems in 'Gelderland-Midden'. This characteristic enables the filling of a matrix with a description of the different relationships within the ecosystem and the subsequent picturing of the existing network.

2.3 Triad Theory and Multilayered Triad Theory

Triad theory first appeared in the work of Simmel (1950) who had a specific interest in "associations of threes". Later in 1985, Granovetter stated that "the triad enables a consideration of actors as both shaping and being constantly shaped by the network of ties bearing upon them" (Siltaloppi & Vargo, 2017, p. 2, 3).

Siltaloppi and Vargo wanted to elaborate on the theory by doing a literature study across multiple disciplines in order to describe different forms of triad relationships. Their research described three types of triad relationships:

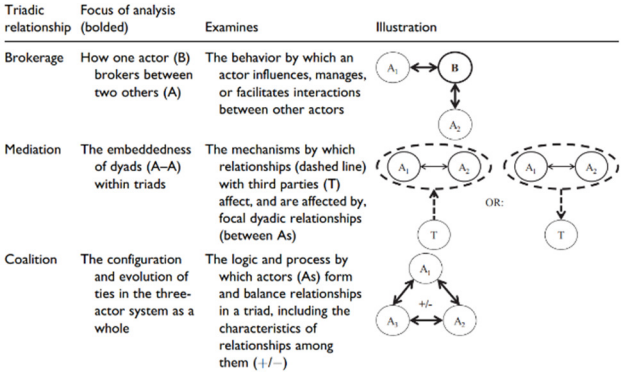

Figure 1: Siltaloppi & Vargo's (2017, p. 4) overview of triadic relationships

Brokerage, focused on the "behavior by which an actor influences, manages, or facilitates interactions between other actors". *Mediation,* focused on "the embeddedness of dyads within triads". And *coalition*, focused "on the configuration and evolution of ties in the three-actor system as a whole, illuminating the logic and process by which actors form and balance relationships in a triad" (Siltaloppi & Vargo, 2017, p. 4, 5).

Kavolevskaya et al. (2021) also presented three different forms of the triad: the open triad, the closed triad and the multilayered triad.

The *open triad* depicts one actor that's connected with two other actors, the *closed triad* depicts each of the three actors connected to the other two actors and the *multilayered triad* depicts two relationships connected on three layers of substance actor bond, resource ties and activity links. These triads were focused on the structure of the triads and less on the specific relationship between actors. Nevertheless, it does not mean that there is no overlap between the six types of triads. The open triad is similar to the brokerage triadic relationship and the closed triad is similar to the coalition triadic relationship (Figure 1 & Appendix 3).

Håkansson and Gadde (2019) painted a global picture of triads and do not mention the different types of triads. Rather they focus on the way triads (three-party constellations) can be embedded in a network (Figure 2) and presented the benefits of learning the triads within an ecosystem.

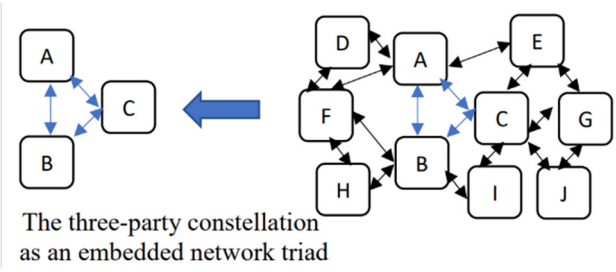

Figure 2: Håkansson & Gadde's (2019, p. 2) overview of an embedded network triad

The actors within triads do their best to use their knowledge and experience related to the activities and resources that define the triad to find (innovative) solutions. The achievements from the implementation of these solutions can, when triads are 'mapped' correctly, be utilized by actors outside the focal triad to innovate their processes. Furthermore, these combinations of network triads will make possibilities appear to design better solutions for

each triad, for instance by reduced complexity or improved performance. “The collective work in connected network triads can be exploited by each of the involved actors.” (Håkansson & Gadde, 2019, p. 4). Meaning that, by discovering the triads all the other actors in the ecosystem are able to learn from other triads to benefit their own triad.

The previously mentioned multilayered triads theory can be seen as a combination of both the previously mentioned ARA model and Triads theory (Appendix 3). This theory was first proposed by A.C. Pedersen in 1987 after which it was adopted by Pedersen and other authors in the paper: ‘Multilayered triads in the context of lean management’ by Kovalevskaya et al. in 2021. Håkansson & Gadde (2019, p. 2) visualized how the ARA model and the triad theory were combined, the singular ‘relationships’ between the actors have been replaced by more detailed relations consisting of the actor bonds, resource ties and activity links (Appendix 3). Furthermore, this research builds on the research from the paper by Kovalevskaya et al. (2021) by revealing how triads are embedded within an ecosystem which their future research recommendation.

This research will use a combination of the different forms of triadic relationships as proposed by Siltaloppi & Vargo (2017) and the multilayered triad as proposed by Kovalevskaya et al. (2021) (Figure 1 & Appendix 3). To describe the different possible triads in order to reveal another dimension of the relationships discovered with the help of the ARA model. This approach will result in three possible forms of the multilayered triads (brokerage, mediation or coalition) that will provide more information on the nature of the relationships within the ecosystem.

2.4 Triads in a Network

Andersson, et al. (2018, p. 256) argue that the triad structures within a network “provide a critical context to understand the nature and relative importance of various inputs” within a network. And goes further by stating that triads have been suggested as the smallest conceivable (connectedness based) unit of analysis. Håkansson and Gadde (2019) agree with this statement and elaborate on it by describing triads as “important building blocks for the functioning of a network, providing some central features to the network”.

The first of these central features has to do with the connected network triads being a vital part in the generation of advantages. By using their specified knowledge to create cost efficient solutions for their own triad. These solutions, if successful, can be implemented by actors in other triads that are directly or indirectly connected via overlapping of the triads. These combinations of triads further the appearance of new possibilities to design better solutions in each triad. This “collective work in connected network triads can be exploited by each of the involved actors” (Håkansson & Gadde, 2019, p. 4).

The second is based on the friction that is generated when two triads become related. Since both triads will “never fit perfectly” they will strive for new (technological, logistical, etc.) solutions “to improve the connections between the individual triad and the network” (Håkansson & Gadde, 2019, p. 4).

Andersson et al. (2018) uses the same three main elements of a network as Kavolevskaya et al. (2021): activity links, resource ties and actor bonds. The geriatric healthcare ecosystem has, *actors* that are defined by their involvement in the giving of care to geriatric patients. A*ctivities* ranging from the actual care giving to the financing of the care and mediation between the patient, family and relevant medical parties. The *resources* involved consist of, among others, the patient’s medical records, communication skills, care giving ability, knowledge of the different medical specialists within ‘Midden-Gelderland’ and money.

A “change of any of these network layers impacts the connections among the elements through adaptation” (Andersson et al., 2018, p. 256). This statement is fortified by Håkansson & Gadde (2019) stating, that the actors within (interconnected) triads will gradually ‘spread’ the solutions through the network while tweaking the solutions, if possible, to the needs of their triads.

The importance of triads as building blocks of a network cannot be ignored making the triad an ideal focus for innovative solutions. Which resulted in an approach based on the effect an innovative solution has on the resource ties of a multilayered triad, and thus on the network/ecosystem as a whole. This research aims to value the impact a solution has on an ecosystem by the solution with the resource ties that could be affected by it within a multilayered triad. Resulting in an overview of the most effective solution.

3. METHODOLOGY

Twelve interviews were conducted among different actors within the geriatric healthcare ecosystem of ‘Gelderland-Midden’ (Appendix 4).

The interviews got transcribed after which the transcribed interviews were imported in ATLAS.ti 22.2.5.0. to be coded in accordance with the three values described in the ARA model; actor bonds, resource ties and activity links (Kavolevskaya et al., 2021; Håkansson & Snehota, 1995).

The results of the analysis of the transcribed interviews were used to fill a matrix consisting of all the different actors and their connections with other actors within the service ecosystem of geriatric healthcare. These connections, or actor bonds in the case of triads, were filled with the different activity links and resource ties that described their relationship. The encountered relationships were pictured in diagrams to make it easier to analyze the found relationships and uncover the embedded triads within those relationships.

The found triads were displayed in multilayered triad diagrams (Appendix 5) and were completed with the data from the matrix filling out the activity links and resource ties between each actor bond within the triad.

The visualization of the triads was complete, however, there was no overview of the geriatric healthcare ecosystem as a whole and how those found triads were embedded within the ecosystem. The network visualization program UCINET enabled just that and was used to make an overview of the ecosystem. The attribute ‘triad’ was connected to the different actors within the triads marking them with a red triangle opposed to the rounded squares that are used for the actors outside of the triads. Furthermore, differently colored lines were manually added to increase visibility of the found triads. This visualization of the network showed the position of the triads within the network as a whole and how these found triads were connected to the other triads.

A table consisting of the found triads, the actor bonds and the resources ties was made to enable the matching of the OPP’s solutions (match, connect & coordinate) with the triad connections. *Match* enables the user to “search and schedule an appointment with the providers with the best-matching clinical expertise and the lowest waiting times”, *connect* enables the users to “securely exchange the data using OPP’s open-source decentralized FHIR API” (a system that enables secure sharing of “sensitive information such as referral letters, medical history, remote monitoring data, etc.)” (https://pact.care/). And

Coordinate helps "healthcare teams to collaborate effectively and to deliver the right care at the right place, using OPP's real-time communication platform" (https://pact.care/). These solutions are based on the resources used in the geriatric healthcare ecosystem, which is the reason for combining the solutions with resource ties that connect the actors within the multilayered triads.

The complete table added the solutions of OPP matched to the resource ties of the actor bond. For example, a medical professional that needed a medical dossier to perform his/her activity would be matched with *connect* since enabling a quick online access to medical documents without having to ask for permission would increase the efficiency of their used resource and thus their activity. The actor bonds and triads were scored on each solution matched with a resource tie, filling the final table with an overview of the most impactful solutions among the solutions offered by OPP.

4. FINDINGS

4.1 Network

UCINET was used to create an overview of the thirty-eight found actors within the geriatric healthcare ecosystem, of these thirty-eight actors nineteen were part of one of the found triads (figure 3).

Legend	
Square Node	'Regular' actor within the geriatric healthcare ecosystem.
Triangular Node	Actor that's part of a triad.
Connection (black)	Connection between 'regular' actors.
Connection (colored)	Connections between actors within a triad.
Color of the connections	**Name of the triad**
Red (■)	Financing of care for people with dementia
Yellow (■)	Day care chain
Green (■)	Circle of care for a patient with dementia – SSL
Cyan (■)	Circle of care for a patient with dementia – District Nursing
Blue (■)	'Casefinding'
Magenta (■)	Care journey of geriatric patients
Orange (■)	First residential coaching triad
Light orange (■)	Second residential coaching triad
Yellow green (■)	First district nursing triad
Light blue (■)	Second district nursing triad
Purple (■)	Geriatric focused workgroup

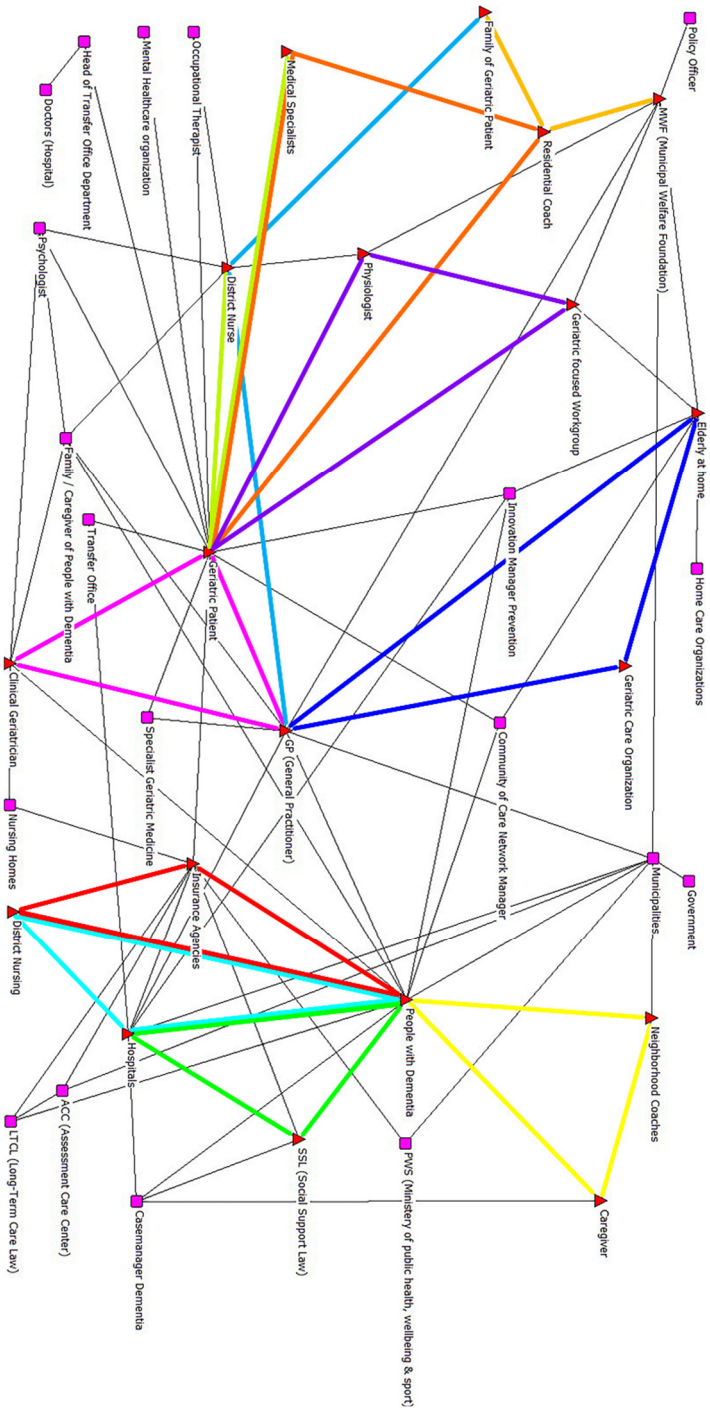

Figure 3: Overview of geriatric healthcare ecosystem and legend

A deviation between the two types of actors has been made in both the shape of the representing symbol as well as the color. Actors that were not part of any found triads were marked with a rounded blue square and the actors connected to the found triads were marked with a red triangle. Colored lines were used to highlight the different connection within a triad. Each triad has a unique appointed color these color-triad combinations are described in the legend of the network (Figure 3).

Some of the actors within the network have a significantly higher amount of connections than other actors within the network. Which can be explained by the focus of the research where the geriatric patient and the subgroup of geriatric patients (people with dementia) form the core of the network. Together with the people in direct contact with the geriatric patients such as: the general practitioner, the district nurse and the hospitals and insurance agencies.

4.2 Multilayered Triads and OPP Solutions

Eleven triads of three different types were found within the network; eight coalition triads, two brokerage triads and one mediation triad. These triads filled a table that described the actor bonds and resource ties of each triad combined with the matched OPP solutions (Appendix 6).

4.2.1 Financing of Care for People with Dementia Triad

This coalition triad describes three connections (*activity links*):

The insurance agency providing insurance to a person with dementia in exchange for an insurance fee.

The insurance agency has to check the patient's medical records in order to make sure that the insured party is 'fairly insured'. So, for instance, not insure a client for a high amount if the client knows that he will die in a short period of time (due to disease). Therefore, access to (part of) the medical records of the client is needed. This makes the 'connect' solution, which enables secure sharing of medical files a great match. Thus, cutting out the waiting times for permission. And the person with dementia has to pay the insurance fee with the resource being money, this resource has no compatible OPP solution.

The person with dementia reaching out to district nursing to talk about the care they need and how district nursing provides the care.

The person with dementia uses communication skills to reach out to district nursing for care. This process of reaching out a care provider, is a match to the 'match' solution. Since a platform that allows the patient to search for the relevant parties with the lowest waiting times would make the process of reaching out more efficient. For district nursing to be able to provide the right care to the person with dementia they need two resources; access to the patient's medical records and district nurses. Access to the patient's medical records is connected to the 'connect' solution. And the 'healthcare team' consisting of district nurses that provide the physical care to the person with dementia, are matched to the 'coordinate' solution. This can assist the district nursing organizations to make their district nurses collaborate effectively by using the real-time communication platform, to ensure that the right care is delivered at the right place without unnecessary hic-ups in the process.

How district nursing sends invoices the insurance agency for the care received by the patient.

This final activity, the paying of the invoice is completely currency-based and has no connection to either of the OPP solutions.

4.2.2 Day Care Chain Triad

This coalition triad describes three connections (*activity links*):

The care giver providing the person with dementia (patient) with care from the comfort of their own home and the patient giving feedback on the received care.

The care giver needs access to the medical records of the patient (related to; allergies, medication, etc.) to be able to give the right personalized care ('connect'). And the person with dementia has to implement their knowledge of their own health (if possible) in order to give feedback to the care giver, this resource (knowing their own health) has no compatible OPP solution.

The care giver reaching out to the neighborhood coaches if the patient's need for care outgrows the caregivers and the neighborhood coaches evaluating if the patient is applicable for day care. The neighborhood coaches will look for alternative solutions for patient and care giver the requirements were not met.

The care giver uses personal experience related to caring for the patient (based on the maximum workload he/she can handle) wither the patient's needs outgrow the care giver's capabilities. This resource (personal experience) has no compatible OPP solution. To be able to evaluate whether the patient is suitable for a day care request insight in the patient's medical records is needed ('connect'). The same resource is needed for looking at alternate solutions that remove some of the pressure from the patient without negatively impacting the care received by the patient.

The conversation between neighborhood coaches and the patient about alternative solutions for the future of his/her medical care when the day care requirement was not met.

The neighborhood coaches need access to the patient's medical records in order to make an educated decision for the patient's future care ('connect'). And the patient needs communication skills and knowledge about their own health to make their wishes known to the neighborhood coaches. Communication skill has no match with the OPP solutions, since the patient does not reach out to as medical specialist so a platform for making appointments would not impact this activity. So, neither of these two resources has a compatible solution.

The positive outcome (the requirements being met) is mention since the activity or arranging day care is connected to an actor (municipalities) outside of the triad.

4.2.3 Circle of Care for a Patient with Dementia – SSL

This coalition triad describes three connections (*activity links*):

The person with dementia (patient) going to a hospital after having an accident in their home (e.g. a fall) and the doctor examining the patient and deciding if the patient is still fit to live in their home without help.

The patient, reaches out to the hospital after a medical emergency (this can be done by a family member or spouse). The ability to call for urgent medical care has no compatibility with the OPP solutions. And the doctor uses a combination of the results of his examination and the medical records of the patient (e.g. to determine if the patient falling frequently) to assess whether it is justified to let the patient live at home without help. The resources used by the doctor are their medical knowledge and the patient's medical records. The doctor's medical knowledge has no compatibility with OPP solutions and the access to patient's medical records is matched to 'connect'.

The doctor deeming the patient unfit for living at home without help and approaching SSL to arrange homecare for the patient. The SSL representative having a conversation about the patient with the doctor.

The doctor provides the reasoning for deeming the patient unfit to live without help based on personal examination and the patient's medical records ('connect'). And the SSL looks at the 'evidence' and decides whether the doctor's claim is valid. It is possible that the SSL representative gets access to the patient's medical records and thus match with 'connect'. However, since this was not proven by the qualitative data found it will not be considered for the results of this research.

The SSL providing the financial part of day care to the patient and the patient indirectly financing the SSL by paying taxes.

Both actors use purely currency-based resources during their activities which resulted in no matching solutions.

4.2.4 Circle of Care for a Patient with Dementia – District Nursing

This coalition triad describes three connections (*activity links*):

The person with dementia (patient) going to a hospital after having an accident in their home (e.g. a fall) and the doctor examining the patient and deciding if the patient is still fit to live in their home without help.

The patient, reaches out to the hospital after a medical emergency (this can be done by a family member or spouse). The ability to call for urgent medical care has no compatibility with the OPP solutions. The doctor uses a combination of the results of his examination and the medical records of the patient (e.g. to determine if the patient is falling frequently) to assess whether it is justified to let the patient live at home without help. And the doctor uses their medical knowledge and the patient's medical records. The doctor's medical knowledge has no compatibility with OPP solutions and the access to patient's medical records is matched to 'connect'.

The doctor referring the patient to district nursing if the patient is being deemed unfit to stay at home without help and district nursing discussing the specifics of the patient's needed home care.

The doctor uses a combination of his/her examination and the patient's medical records ('connect') to inform district nursing about the specifics of the needed care. And district nursing shares their experience with facilitating home care for people with dementia. However, the experience of district nursing with home care of people with dementia do not match with any of the solutions.

District nursing delivering the needed care to the patient and the patient giving feedback on the given care.

The district nursing organization sends a district nurse to care for the patient. The district nurse (as human resource) can be combined with the 'coordinate' solution since the real-time communication platform proposed by OPP could help organize the different district nursing organizations into more unified healthcare teams. And the patient uses their experience with the given care to provide feedback to the district nurse, this resource has no matching solution.

4.2.5 'Casefinding' Triad

This coalition triad describes three connections (*activity links*):

The general practitioner sending out a survey to elderly at home and the elderly at home sending a filled-out survey back to the general practitioner.

The general practitioner uses a survey to get elderly at home to open up about their medical needs. And the elderly at home uses the knowledge of their own health to fill out the survey. Neither one of these resources can be linked with the given solutions.

The general practitioner reaches out to 'Geriatric Care Organization' if concerns were raised in relation to the filled-out survey and a representative of 'Geriatric Care Organization' will pay a visit to that specific elderly person at home and report the results back to the general practitioner.

The general practitioner uses knowledge from the survey to inform the 'Geriatric Care Organization' representative. And 'Geriatric Care Organization' uses representatives to check-in on the elderly at home and report back to the general practitioner. This resource can be matched with the solution 'coordinate', the real-time communication platform would make the interaction between general practitioner and representative from 'Geriatric Care Organization' more efficient by creating a direct connection between these two actors.

The 'Geriatric Care Organization' representative having a conversation about the health of the elderly at home and the elderly person at home answering the asked questions.

The representative uses their communication skills in order to get to know more about the specific health related issues that the elderly person at home filled into the survey. And the elderly person at home uses the knowledge of their own health and encountered problems during daily activities to answer the questions of the 'Geriatric Care Organization' representative. Neither of these resources can be matched to one of the OPP solutions.

4.2.6 Care Journey of Geriatric Patients

This coalition triad describes three connections (*activity links*):

The clinical geriatrician having up to three meetings with the geriatric patient. The patient answering the questions of the clinical geriatrician. The clinical geriatrician making a diagnosis and sort the ailments of the patient based on: health risk, level of discomfort/pain experienced, the specialist(s) needed to resolve the problem and the effect the ailment has on quality of life. The Patient and the clinical geriatrician planning on how to improve the patient's quality of life.

The clinical geriatrician uses the patient's medical records to use as a base for the conversation with the geriatric patient ('connect'). And the geriatric patient uses their communication skills to answer the questions and uses their day to day experience with deteriorating mental and/or physical health to create a plan on how to increase quality of life with the clinical geriatrician. These resources are not connected to one of the OPP solutions.

The clinical geriatrician reaching out to the general practitioner if a dilemma is encountered during the diagnosing of the patient. The general practitioner giving advice on the dilemma.

Both the clinical geriatrician and the general practitioner make use of the patient's medical records ('connect'). The clinical geriatrician uses the records to add context to the dilemma and the general practitioner uses the medical records to base their advice on.

The general practitioner transferring knowledge to the patient to help him/her to acknowledge their own responsibility (e.g. if an elderly person keeps tripping and falling in the dark, a nightlight could help with visibility and thus decrease the chance of tripping). The patient joining the conversation about their own responsibility. And the general practitioner arranging the care that the patient needs personally or by referral to a medical specialist (physiologist, psychologist, etc.).

The general practitioner uses the patient's medical records to build a 'case' for the patient's own medical responsibility ('connect'. And the geriatric patient uses communicational skills to join the conversation about responsibility, this resource cannot be matched to the OPP solutions.

4.2.7 First Residential Coaching Triad

This coalition triad describes three connections (*activity links*):

The geriatric patient calling the residential coach with living or moving related questions and the residential coach having a meeting with the patient to talk about their living situation based on: mobility, social contacts, motivation to participate in activities and how to improve these aspects of the patient's life.

**The patient gets a couple of days up to a week to think the conversation over, afterwards another meeting will be held to decide the future of the patient*.*

The geriatric patient uses his/her communicational skills to call the residential coach. The 'match' solution is the best fit for this resource. Since the use of OPP's platform could make the old way of contacting geriatric patients (handing out flyers) obsolete by enabling the patient to look for the relevant residential coach with the lowest waiting time. And the residential coach uses his/her experience with the living and moving related issues encountered by geriatric patients to inform them of each aspect of moving or adapting your house to an older lifestyle. This resource cannot be matched to a OPP solution.

The residential coach reaching out to the relevant medical specialist for the patient's needs (e.g. a patient with low mobility to a physiologist) and the medical specialist discussing the patient's future care.

The residential coach uses their knowledge of the different medical specialists within 'Gelderland-Midden' to match their patient's needs for care with the medical specialist that can provide the care. The 'coordinate' solution is the best fit for this resource. The OPP platform will enable more efficient collaboration between the residential coach and the medical specialist with a real-time communication platform. Making the residential coach less dependent on their own networking ability and enabling them to reach out to any of the existing medical teams within 'Gelderland-Midden' to arrange the right care at the right place. And the medical specialists use a combination of their specialized medical knowledge and the patient's health record ('connect') to discuss the best possible care for the patient with the residential coach. The first resource cannot be connected to a OPP solution.

The medical specialist using their specialty to treat the patient and the patient giving feedback on the received care and letting personal preferences known.

The medical specialist uses the previously discussed form of care to treat the patient. And the patient uses the knowledge of their own health and the experience with the received care. Neither of the previously mentioned resources can be matched with a OPP solution.

4.2.8 Second Residential Coaching Triad

This brokerage triad elaborates on the first residential triad by describing two *activity links*:

The residential coach having meetings with the family of the client to make sure that their wishes are considered in the decision-making process and the family making their wishes known. Enabling both actors to create a plan of care together.

The residential coach uses their knowledge of the patient's health to inform the family of the client about the needed care in the future. This resource fits with the 'connect' solution, as the residential coach has to base their knowledge on (part of) the medical records of the patient. And the family of the geriatric patient uses communicational skills to share their wishes for the future care of the patient. This resource fits with the 'match' solutions since OPP's platform can help making the reaching out for the patient as well as the family of the patient to the residential coach easier.

The residential coach reaching out to the MWF to find the relevant medical specialist needed for the plan of care and MWF sending the contact info of the relevant specialists to be contacted by the residential coach.

The residential coach uses (part of) the patient's medical records to inform MWF about the ailments of the people. The 'connect' solution is the best solution for this resource since giving both parties (partial) access to the patient's medical records will remove the step of the residential coach having to inform MWF about the ailments of the patient. Enabling MWF to immediately refer the residential coach to the relevant specialist, so MWF can spend their efforts on other activities such as: their workgroups focused on stimulating the elderly population in Lingewaard to exercise more. And MWF uses their knowledge on the different medical specialists within Lingewaard to refer the patient to the relevant specialist. The 'coordinate' solution is the best fit for this resource since a platform consisting of all the relevant medical actors in Gelderland-Midden will make the process of finding the right medical specialist more efficient. By making the 'mediating role of MWF obsolete, thus decreasing the number of steps in the process.

4.2.9 First District Nursing Triad

This coalition triad describes three connections (*activity links*):

The district nurse helping the patient with the start of their day, assisting the patient with medication, wound care and accompanying the client through social and emotional hardship. And the patient giving feedback on the received care and his/her caring needs.

The district nurse uses (part of) the patient's medical records to be able to give the right care to the patient. This resource fits with the 'connect' solutions, since it provides the medical parties that need access to medical files with easy and secure access. And the geriatric patient uses their experience with the given care and knowledge of their own body to provide feedback to the district nurse. These resources have no matching solution.

The district nurse being alert on the medical and mental health of the patient during his/her time with the patient, reaching out to a medical specialist if the patient's condition is getting worse. And the medical specialist giving advice to the district nurse on potential treatments.

The district nurse uses his/her experience with caring for geriatric patients to decide when referral is necessary after which he/she will use their knowledge of relevant medical specialist to refer the patient. The first resource has no matching solutions, the second resource matches with 'coordinate'. This solution will increase the knowledge that the district nurse has of the medical specialists within Gelderland-Midden while simultaneously making the reaching out to the relevant medical actor easier on the OPP platform. And the medical specialist uses a combination of their specialized skill and the patient's medical record. The 'connect' solutions has the best fit with this resource, due to the secure access of medical files for relevant medical actors.

The medical specialist treating the geriatric patient and the geriatric patient giving feedback on the given care and personal preference.

The medical specialist uses a combination of the patient's health records to prepare for the procedure and their specified medical skills to treat the patient. The first resource matches with 'connect', enabling more efficient and secure online-access to medical files to the authorized parties. The second resource has no matching solutions. And the geriatric patient uses their knowledge of their own body/health to let personal preferences known. This resource has no matching solutions.

4.2.10 Second District Nursing Triad

This brokerage triad elaborates on the first district nursing triad by describing two *activity links*:

The district nurse involving the family of the geriatric patient in the decision-making process and the family of the geriatric patient making their wishes known for future care of the patient.

The district nurse uses a combination of the patient's health records and their knowledge on the available medical specialists to inform the family of the geriatric patient about the caring possibilities. The first resource fits best to 'connect', since this provides secure access to the relevant medical files online. Increasing the efficiency of the process. The second resource fits best to 'coordinate' since this solution will make the district nurse less dependent on their own (limited) knowledge on the available medical specialist while simultaneously enabling communication between the district nurse and the medical specialist. And the family of the geriatric patient uses their knowledge of the patient's (or family members) wishes, insurance, finance, etc. to decide, together with the district nurse, what the best possible care for the patient is. This resource has no matching solutions.

The district nurse discussing a dilemma related to the future care of the patient with the general practitioner and the general practitioner giving a recommendation regarded to the need for treatment by the general practitioner or referral to a medical specialist.

The district nurse uses communicational skills, this resource is matched with 'coordinate' as this solution will make the reaching out to other medical professionals within the region near instant with access to an online real-time communication platform. And the general practitioner uses a combination of the patient's medical records and their knowledge of the medical specialist within the region. The first resource is matched with 'connect' because of the OPP's platform enabling quick and secure access to medical files. The second resource is connected with 'coordinate' since the platform will give the general practitioner access to all medical parties within the region with real-time communication possibilities.

4.2.11 Geriatric Focused Work Group (MWF) Triad

This mediation triad describes two activity links:

The geriatric patient reaching out to the physiologist when an injury or ailment occurs and the physiologist having check-ups with the geriatric patient to look after those injuries and/or ailments.

The geriatric patient uses a combination of communicational skills and knowledge of their own body. The first skill is matched with 'match' as this solution increases the ease and efficiency of a patient reaching out to/and making an appointment with a medical specialist. The second resource has no matches with either of the solutions. And the physiologist uses a combination of both the patient's health records and their own medical skill. The first resource is matched with 'connect', since it enables quick and secure access to the relevant medical files. The second resource could not be matched with a solution.

The information on the recovery and the ability to partake in activity days of the geriatric patient, generated in the first activity link, being shared with the geriatric focused workgroup and the geriatric focused workgroup adapting the activities to the capabilities of the patient and patients that share those capabilities.

The information from the 'geriatric patient – physiologist' relationship is shared in the form of medical files. This resource is matches with 'connect' since this solution can make the sharing of this information obsolete by given both parties access to the relevant medical information. And the geriatric focused workgroup uses employees (or volunteers) and digital filling servers (to hold the relevant medical information). The first resource is matched with 'coordinate' since OPP's platform will increase the speed and efficiency of the communication between the different physiologist and the workgroup. The second resource is matched with 'connect' since secure access to medical files will make personal data filling server obsolete, enabling multiple authorized parties to access and share data and increasing efficiency by removing the time-consuming activity of asking permission for these files.

4.2.12 OPP Solutions

An overview of the previously described resource ties and the matching OPP solution are summarized in figure 4.

OPP Solutions	Amount of matched resource ties	Most common match per triad
Match	4	0 (1)
Connect	25	8 (2)
Coordinate	10	1 (2)

Figure 4: OPP solutions and triads

Out of the three solutions, *connect*, has been represented the most with twenty-five matches within the resource ties of the triads. Which is also shown by this solution being the most common match within eight triads. This is explained by each medical expert needing medical files on their patient to do their job. It would save a lot of time and increase the efficiency of the geriatric ecosystem if medical dossiers could be accessed on a secured platform. Thus, eliminating requests for access and waiting times for viewing the desired documents. Furthermore, this solution will make requests for, among others, day care more efficient with the creation of a file that can be accessed by all the relevant parties without the request being send between the different departments.

The second most influential solution is *coordinate* with ten resource tie matches, being the most common match within one triad and tying for most common match in two triads. This relatively low number, compared to connect, can be explained by the found triads portraying a larger amount of direct relationships between geriatric patients and a healthcare teams that use the patient's medical records and less on the collaboration between multiple healthcare teams. An example of the collaboration of healthcare teams would be multiple district nursing organization that could use OPP's real-time communication platform to coordinate which organization should deliver the care and how it will be delivered at the right place on the right time.

The last and least influential solution is *match* with four resource tie matches and one tie for most common match within a triad (number between brackets). Never the less this solution can help the ecosystem, as a platform that enables the user to search and make appointments with the relevant medical specialist that would make relationships as seen in the second residential coaching triad (Appendix 6) obsolete. Since MWF acts as a connection between the medical specialists and client which could become obsolete if OPP's platform is used to connect the client with a medical specialist.

5. DISCUSSION AND CONCLUSION

This thesis conducted qualitative research based on fifteen interviews among actors within the geriatric healthcare ecosystem, to answer the question: *To what extent can embedded multilayered triads contribute to the service development within the service ecosystem of geriatric healthcare in Gelderland-Midden?*

The use of the multilayered triad theory revealed a geriatric healthcare ecosystem network consisting of thirty-eight actors with eleven embedded triads. The importance of triads within networks is stated in multiple papers such as: Andersson et al. (2018) and Håkansson and Gadde (2019).

Which formed the foundation for the matching of the resource ties within the found triads with the three OPP solutions. The combined number of matches revealed the most influential solution among these three. This decision was based on the highest impact on the triad connections, the triads and therefore the network as a whole.

The embedded multilayered triads can give a lot of information on the impact that a specific solution would have on the network. This information can be used to decide how to act on a solution, quitting the implementation of a solution or focusing more on a specific solution from a selection of solutions like this research. So, to answer the research question the embedded multilayered triads within a network can severely influence the solution-based decision making within a network.

The previously stated information is combined into a recommendation for OPP to focus their efforts on the connect solution. Since ensuring that this part of the platform performs well and keeps performing well will impact the largest part of the network and thus, result in the biggest improvement of geriatric healthcare in 'Gelderland-Midden' as a whole.

6. LIMITATIONS AND RECOMMENDATIONS

The first limitation of this research is based on the lack of interviews with the patients themselves, which could have been a good way to check the found relationships. However, there is a problem with the interviewing of some of the geriatric patients especially patients that are in a further stage of dementia that would not be able to partake. So, for future research the patient themselves or the family of the patients should be interviewed. Furthermore, one third of the interviewees was an employee of Rijnstate. This can be explained by the large impact that Rijnstate has within the geriatric healthcare ecosystem of 'Gelderland-Midden, with their hospital based in capital of this region. Rijnstate's size could have taken away attention from the 'smaller' actors that partake in the same activities.

For future research the data set could be expanded by looking at the actors in the network with the lowest amount of connections and conduct interviews with these actors to discover new activity links and resource ties to increase the map's coverage of the geriatric healthcare ecosystem. This increased coverage can be used to find more embedded triads and compare resource-solution combination that can describe the relevance and impact of new innovative solutions within the geriatric healthcare ecosystem. Such as the solutions that OPP provided for the European project.

Another recommendation for future resource is based on Siltaloppi and Vargo's (2017) work being approached in a descriptive way in this research. For future research it could be interesting to approach the theory from an explanatory perspective in order to explain the ('real-time') impact that the solutions will have on multilayered triads within the geriatric healthcare ecosystem.

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9. APPENDIX

9.1 Appendix 1: Age of Dutch Population in Percentages

Bevolking naar leeftijd, per 1 januari (%)

Leeftijd	jonger dan 20 jaar	20 tot 40 jaar	40 tot 65 jaar	65 tot 80 jaar	80 jaar of ouder
2021	21	25	34	15	5
2000	24	30	32	10	3
1975	34	30	26	9	2
1950	37	29	26	7	1

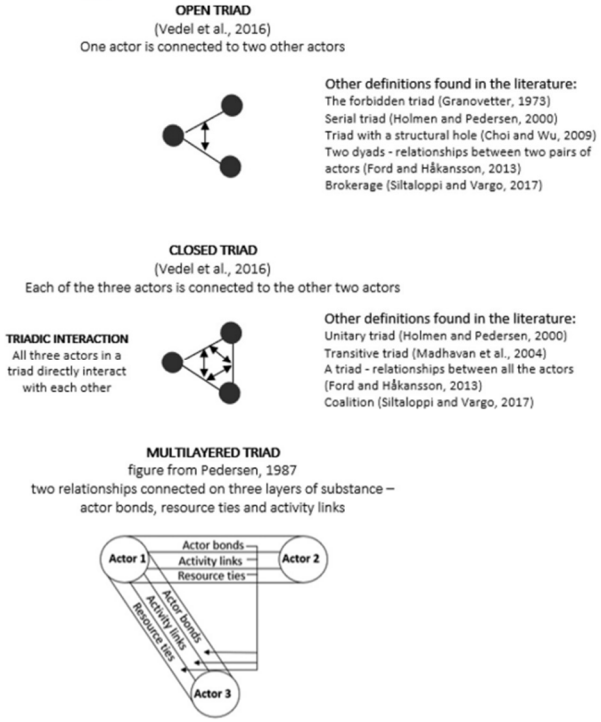
Source: CBS.nl, 2022

9.2 Appendix 2: Population of the Province Gelderland

Population of the Province Gelderland	Number of citizens
Total population:	
1988	1.783.610
2000	1.919.158
2013	2.015.791
2021	2.096.603
2022 (up till the 30th of May)	2.110.472
Total elderly (age ≥ 65) population:	
1988	217.211
2000	260.975
2013	349.738
2021	435.211
2022 (up till the 30th of May)	445.017
Percentage of elderly citizens in the population:	
1988	12%
2000	14%
2013	17%
2021	21% (20,8%)
2022 (up till the 30th of May)	21% (21,1%)

Source: opendata.cbs.nl, 2022

9.3 Appendix 3: Overview of Triad forms

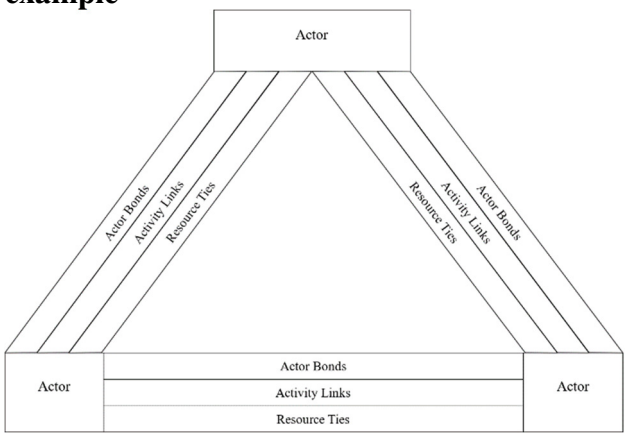


Source: Kavolevskaya et al., 2021, p. 2

9.4 Appendix 4: List of interviewees' professions

Profession	Organization
Project Leader Sport	Municipal Welfare Foundation
Department Manager	Municipality within Gelderland-Midden
Network Manager	Advisory Organization for good care and health nearby
Prevention Innovation Manager	Hospital
Head of the Transfer Agency	Hospital
Information Manager	Hospital
Network Coordinator	Dementia Organization
Network Coordinator	Dementia Organization
General Practitioner	None
Residential Coach	Municipal Welfare Foundation
Clinical Geriatrician	Hospital
District Nurse	District Nursing

9.5 Appendix 5: Multilayered triad diagram example



9.6 Appendix 6: Table of Triads and OPP solution findings

The table can be found on the next page in order to create the clearest possible picture of the table.

*Text between * * could not be found in the interviews and is filled with the help of logic within the context of the interviews. This information's is added to make the triads complete and, since it is not based on the qualitative data, will not be used for the matching with OPP solution*

Triad and Actor Bonds	Resource Ties	Matched Pact Care Solution	Connect	Match	Coordinate
Financing of Care for People with Dementia		Total:	2	1	1
Insurance agent – Insurance fee payee	Health records of the patient – Money	Connect – None	1	0	0
District Nursing – Insurance Agency	Care giving capabilities – Contractual agreement with insured party	None	0	0	0
District Nursing – People with Dementia	Health records of the patient & District nurses – Communication skills	Connect, Coordinate – Match	1	1	1
Day Care Chain		Total:	3	0	0
People with dementia – Care Giver (personal)	Knowledge of their own health – Health records of the patient	None – Connect	1	0	0
Care giver – Neighborhood Coach	Knowledge about the patient's health – Health records of the patient	None – Connect	1	0	0
Neighborhood coach – People with dementia	Health records of the patient – knowledge about their personal health	Connect – None	1	0	0
Circle of Care for a Patient with Dementia – SSL (social support law)		Total:	2	0	0
People with dementia – Hospital	Knowledge of their own health – The patient's health records	None – Connect	1	0	0
Hospital – SSL	The patient's health records – *The patient's health records*	Connect – None	1	0	0
Patient with Dementia – SSL	Money (taxes) – Government funding & knowledge of relevant laws	None – None	0	0	0
Circle of Care for a Patient with Dementia – District Nursing		Total:	2	0	1
Patient with dementia – Hospital	Knowledge of their own health – The patient's health records	None – Connect	1	0	0
Hospital – District Nursing	The patient's health records – *Health records of the patient*	Connect – None	1	0	0
Patient with Dementia – District Nursing	*Money* – Ability to provide near instant care to patients with dementia	None – Coordinate	0	0	1
"Casefinding"		Total:	0	0	1
GP - Elderly at Home	A survey that enables people to voice their healthcare needs – Ability to voice their need for care	None	0	0	0
GP – Geriatric Care Organization	The information from the filled-out survey – ' Geriatric Care Organization' representative	None – Coordinate	0	0	1
Geriatric Care Organization – Elderly at home	Communication skills, information from the filled-out survey – knowledge about their own health	None	0	0	0

Triad and Actor Bonds	Resource Ties	Matched Pact Care Solution	Connect	Match	Coordinate
Care Journey of Geriatric Patients		Total:	4	0	1
Clinical Geriatrician – Geriatric patient	The patient's health records – Communication skills	Connect – None	1	0	0
General Practitioner – Clinical Geriatrician	The patient's health records – The patient's health records	Connect – Connect	2	0	0
General Practitioner – Geriatric patient	Knowledge of the different care providers in 'Gelderland-Midden', The patient's health records – *Being willing to partake in the conversation*	Connect, Coordinate – None	1	0	1
First Residential Coaching Triad		Total:	1	1	1
Residential Coach – Geriatric Patient	Experience with the living and moving related issues encountered by geriatric patients – Communication skills	None – Match	0	1	0
Medical Specialists – Residential Coach	The patient's health records – Knowledge of the different medical specialist in 'Midden-Gelderland'	Connect – Coordinate	1	0	1
Medical Specialists – Geriatric Patient	*The patient's health records* – Knowledge of their own health and experience with the received care	None	0	0	0
Second Residential Coaching Triad		Total:	2	1	1
Family of Geriatric Patients – Residential Coaching	Communication skills – The patient's health records	Match – Connect	1	1	0
Residential Coaching – Municipal Welfare Foundation (MWF)	The patient's health records – The best knowledge of the medical specialist in their municipality	Connect – Coordinate	1	0	1
First District Nursing Triad		Total:	3	0	1
District Nurse – Geriatric Patient	Health records of the patient – Knowledge about their health	Connect – None	1	0	0
Medical Specialists – District Nurse	The patient's health records – Experience with the patient, connections with medical specialists	Connect – Coordinate	1	0	1
Medical Specialists – Geriatric Patient	The patient's health records – Knowledge about their health	Connect – None	1	0	0
Second District Nursing Triad		Total:	2	1	2
District Nurse – Family of Geriatric Patient	Health records of the patient, knowledge about the different medical specialists in 'Midden-Gelderland' – Knowledge about the patient's wishes, insurance, finances, etc.	Connect, Match – None	1	1	0
General Practitioner – District Nurse	The patient's health records, knowledge of the different medical specialists in 'Midden-Gelderland' – Communicational skills	Connect, Coordinate – Coordinate	1	0	2
Geriatric Focused Workgroup (MWF)		Total:	3	1	1
Physiologist – Geriatric patient	Health records of the patient – knowledge of their own ailments/injuries	Connect – Match	1	1	0
Geriatric focused Work Group – (Physiologist – Geriatric patient)	Digital filling servers to hold medical records, employees and volunteers – Information about the geriatric patient's health	Connect, Coordinate – Connect	2	0	1