Juha Kemppinen

THE DEVELOPMENT AND IMPLEMENTATION OF THE CLINICAL DECISION SUPPORT SYSTEM FOR INTEGRATED MENTAL AND ADDICTION CARE

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Supervisors Professor Timo Kärri
LUT School of Engineering Science
Lappeenranta-Lahti University of Technology LUT
Finland

Associate Professor Kalle Elfvengren
LUT School of Engineering Science
Lappeenranta-Lahti University of Technology LUT
Finland

Docent Jukka Korpela
LUT School of Engineering Science
Lappeenranta-Lahti University of Technology LUT
Finland

Reviewers Assistant Professor Antti Peltokorpi
School of Engineering
Aalto University
Finland

Professor Hannu Koponen
Department of Psychiatry
University of Helsinki
Finland

Opponent Assistant Professor Paulus Torkki
Department of Public Health
University of Helsinki
Finland

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Abstract

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For 60 years, clinical decision support systems (CDSS) have helped clinicians solve their daily chores. Initially, CDSSs were computer-assisted aids for diagnosing individual patient cases. The newest version of CDSS is using artificial intelligence, machine learning, deep learning, artificial neural networks, and genetic algorithms to solve the complex problems of health care. This dissertation is about the developed CDSSs of the key processes in the implementation of a new integrated mental and addiction care clinic (MTPA).

The previous separately organized service systems of mental health and addiction care were fragmented and inefficient. A redesign of the service systems and effective implementation methods was needed. The developed CDSSs offered an efficient way to implement a new clinic within a narrow time frame. The CDSSs of adult ADHD, the evaluation of the working ability of psychiatric patients, and the opioid substitution therapy were the key processes designed in focus groups of multi-professional teams to align the various duties of different mental and addiction care professionals in the southeast of Finland.

Process and systems thinking, organizational development and systems science were the background theories of this dissertation. These manufacture-originated theories were applied in a joint team effort in a real work-life situation to the core processes of the new clinic. The results of using these theories were mostly successful. The CDSS-assisted key processes eliminated long waiting lists altogether and facilitated new patient groups entering the clinic. The clinic achieved a benchmarking status in integrated mental and addiction care in Finland. The CDSS-assisted key processes of the clinic formed an agile, efficient, and productive way of reorganizing and implementing psychiatric and addiction care operations. This dissertation contributes similar efforts to reorganizing and developing health care service systems.

Keywords: mental health care, process, business process management, reengineering, clinical decision support system, Lean thinking, design science, health operation research, organizational development

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I am privileged to have many good friends. Especially relaxing moments were spent in our Platon club, and many interesting moments and discussions were held with Sanna, Maija-Liisa, Kirsi, Lauri, Jyrki, Timmo, and Tommi. They have also offered their valuable support during the various obstacles and challenges normal life has to offer.

Juha Kemppinen
September 2020
Lappeenranta, Finland

To the love of my life, my wife Johanna.

Contents

List of publications

This dissertation is based on the following papers. The rights have been granted by publishers to include the papers in dissertation.

I. Kemppinen J., J. Korpela, K. Elfvengren, T. Salmisaari, J. Polkko and M. Tuominen. (2013). "A Clinical Decision Support System for Adult ADHD Diagnostics Process", 46th Hawaii International Conference on System Sciences, January 7–10, 2013, Maui, Hawaii. Jufo 1.

The author planned the study with the co-authors. The author was responsible for developing the design of the adult ADHD clinical decision support system model with the co-authors and writing and revising the publication.

II. Kemppinen J., J. Korpela, K. Elfvengren, T. Salmisaari and J. Polkko. (2014). "Decision Support in Evaluating the Impacts of Mental Disorders on Work Ability", 47th Hawaii International Conference on System Sciences, January 6–9, 2014, Waikoloa, Big Island, Hawaii. Jufo 1.

The author planned the study with the co-authors. The author was responsible for developing the design of the mental disorders work ability evaluation clinical decision support system model with the co-authors and writing and revising the publication.

III. Kemppinen J., J. Korpela, K. Elfvengren and J. Polkko. (2015). "Clinical Decision Support System for Opioid Substitution Therapy", 48th Hawaii International Conference on System Sciences, January 5–8, 2015, Grand Hyatt, Kauai. Jufo 1.

The author planned the study with the co-authors. The author was responsible for developing the design of the opioid substitution therapy clinical decision support system model with the co-authors and writing and revising the publication.

IV. Kemppinen J., J. Korpela, K. Elfvengren, J. Polkko and M. Tuominen. (2014). "Redesigning Mental Health Care Service Processes to Increase Productivity", The 18th International Working Seminar on Production Economics, February 24–28, 2014 Innsbruck, Austria.

The author planned the study with the co-authors. The author was responsible for conducting the redesigning changes in practice and with the co-authors writing and revising the publication.

V. Kemppinen J., J. Korpela, K. Elfvengren, J. Polkko and M. Tuominen. (2014). "Increasing Productivity in Mental Health Care Services with an Integrated Process and Diagnostics Support System", The 19th International Conference on

Transformative Research in Science and Engineering, Business and Social Innovation, June 15–19, 2014, Kuching, Sarawak, Malaysia.

The author planned the study with the co-authors. The author was responsible for conducting the productivity changes in practice and with the co-authors writing and revising the publication.

VI. Kemppinen J, J. Korpela, K. Elfvengren and J. Polkko. (2017). "Improving the Productivity and Efficiency of an Integrated Mental and Addiction Care – An Application of the Theory of Constraints and Five-focusing Step to Evaluation of Adult ADHD Patients", Finnish Journal of eHealth and eWelfare, vol. 9, no. 1, p. 18–30. Jufo 1.

The author planned the study with the co-authors. The author was responsible for conducting the productivity and efficiency changes in practice and with the co-authors writing and revising the publication.

Nomenclature

Abbreviations

5FS	The five-focusing step
ADHD	Attention-deficit hyperactivity disorder
AI	Artificial Intelligence
AMPS	The Assessment of Motor and Process Skills
ASRS v1.1	ADHD Self-Report Scale
AUDIT	Alcohol Use Disorders Identification Test
BA	Business Analytics
BI	Business Intelligence
BN	Bayesian Network
BPM	Business Process Management
BPR	Business Process Reengineering
BPRS	The Brief Psychiatric Rating Scale
CAS	Complex Adaptive System
CDS	Clinical decision support
CDSS	Clinical decision support system
CEO	Chief executive officer
COO	Chief operating officer
CPOE	Computerized provider order entry
CPR	Computer-based patient records
CQI	Continuous quality improvement
DALY	Disability-adjusted life years
DIVA	Diagnostic Interview for ADHD in adults
DPT	Dual process theory
DSM	The Diagnostic and Statistical Manual of Mental Disorders
DSR	Design Science Research
DSRIS	The Design Science Research in Information System
DSRM	Design science research methodology
DSS	Decision support systems
EBM	Evidence-based medicine
EHR	Electric health record
EIS	Executive information system
EKP	Emerging knowledge processes
Eksote	The South Karelia District of Social and Health Services
EMR	Electronic medical records
ERP	Enterprise resource planning
ES	Expert system
EuropASI	European Addiction Severity Index
GA	Genetic Algorithm
GDSS	Group decision support system
GP	General practitioner

HBIS	Hospital-based business intelligent system
HIS	Hospital information systems
HITECH	Health Information Technology for Economic and Clinical Health
hOM	Health operation management
IBM	International Business Machines Corporation
ICD-10	International Statistical Classification of Diseases and Related Health Problems
ICT	Information and communication technology
iMode	The packet-based service for mobile phones offered by Japan's leader in wireless technology
IMS	Integrated management system
IOM	The Institute of Medicine
IS	Information systems
ISDT	Information system design theory
ISO 9001	International Organization for Standardization
IT	Information technology
ITSM	Information Technology Service Management
JCAHO	Joint Commission for Accreditation of Healthcare Organizations
JIT	Just In time
KASTE	The Finnish National Development Program for Social Welfare and Health Care
LSS	Lean Six Sigma
MADRS	The Montgomery–Åsberg Depression Rating Scale
MASTO	The Finnish project aimed to tackle depression as cause of work incapacity, the Programme for Social Welfare and Health Care
MDQ	The Mood Disorder Questionnaire
MIELI	The national plan for mental health and substance abuse work (Finland)
MIS	Management information system
MIT	Massachusetts Institute of Technology
MOHOST	The model of Human Occupational Screening Tool
MTPA	A new integrated mental and addiction care clinic
NEJM	New England Journal of Medicine
OD	Organizational development
OSA	Occupational Self-Assessment
OST	Opioid substitution treatment
PC	Personal computer
PHI	Personal Health Information
POE	Physician order entry
PRISM	Psychiatric Research Interview for Substance and mental Disorders
PROD	Prodromal symptoms of psychosis
Ps 1, 2, 3	Psychiatric inpatient departments
ODSS	Organization decision support system
QMS	Quality management system
RQ	Research question

SCID	Structured Clinical Interview for DSM-IV Axis I Disorders
SBM	Solution Business Manager
SCM	Supply chain management
SDS	The Severity of Dependence Scale
SOFAS	Social and Occupational Functioning Assessment Scale
SPC	Statistical process control
SPM	Sequential pattern mining
THL	The National Institute for Health and Welfare (Finland)
TPS	Toyota Production System
TOC	The theory of constraints
TQM	Total quality management
VOC	Voice of customer
VUI	Visualization user interface
WAIS-III	Wechler Adult Intelligence Scale - III
WAP	Wireless Applications Protocol
WIP	Work In-Progress
WML	Wireless Markup Language
WMS-III	Wechler Memory Scale - III
YLD	Years lived with disability
YMRS	Young Mania Rating Scale
Z00.4	Unspecified psychiatric visit

1 Introduction

The first chapter introduces current practical problems in delivering services in health care generally and in mental and addiction care service systems specifically internationally and locally in Finland. The background and motivation for the research of (re)designing, developing and establishing integrated mental and addiction care organizations, processes, and operations lie in creating designed IT-artefacts and in presenting process- managed organizations. The positioning of the research, as well as the outline of this dissertation, are presented in the first chapter.

1.1 Background and motivation

Psychiatric care systems have gone through profound changes in Europe and Finland since the 1980s. The deep economic depression in Finland in the 1990s forced some budget cuts on health care. The psychiatric secondary and tertiary care lost most of their resources (about 40%; Lehtinen and Taipale 2005, 364) in secondary care hospitals in the rapid structural changes of the 1990s. In 1991, previously autonomous specialized psychiatric care was merged into the general, specialized care in general hospitals. The deinstitutionalization of mental hospitals aimed to promptly diminish psychiatric inpatient care, and a (mainly municipal) psychiatric open ward was developed. The number of psychiatric inpatient beds diminished from about 20 000 beds in the 1980s to about 12 300 beds at the beginning of the 1990s, and to about 5 000 beds in 2002. At the same time, the number of treated patients remained the same, which meant a dramatically shortened length of stay in psychiatric hospitals (Lehtinen and Taipale 2005, 361–366). Previous psychiatric hospitals in the health care districts were closed, and psychiatric care was "municipalized". Several municipalities, in the name of economic pressure and insourcing, established their psychiatric care systems (Harjajärvi et al. 2006).

In the 1980s, the central agency of health care (Lääkintöhallitus, merged in the the Finnish Ministry of Social Affairs and Health in 1991) dictated the design and functionality of mental hospitals. In the 1990s, over 400 municipalities in Finland could arrange their psychiatric care according to the Municipal law (finlex.fi) as "the need in the area necessitated". No exact definition of what the need for psychiatric care in the specific area meant or means existed then nor exists now. (Lehtinen and Taipale 2000, 99–119).

At the beginning of the 21st century, we had difficulties in delivering proper care for dual diagnoses patients (who had both addiction and mental health diseases). We tried to figure out "the archeology of mental care clinic". How was it possible to have such an inefficient system of talented people working around the dual diagnoses patients (Figure 1)? This mystery of an inefficient health care system chased me. Similar observations of the health care system had been made by several scientists (Vuori 1996; Seddon 2008; Storm et al. 2019), for example half of psychiatric care had been transferred from specialized health-care units to municipal health centres (Harjajärvi et al. 2000). It motivated me to study the possibility of organizational change – agile, efficient, and productive integrated

mental and addiction care. This dissertation is about solving the complexities of the health-care system, the perennial and wicked practical problems of integrating mental and addiction care.

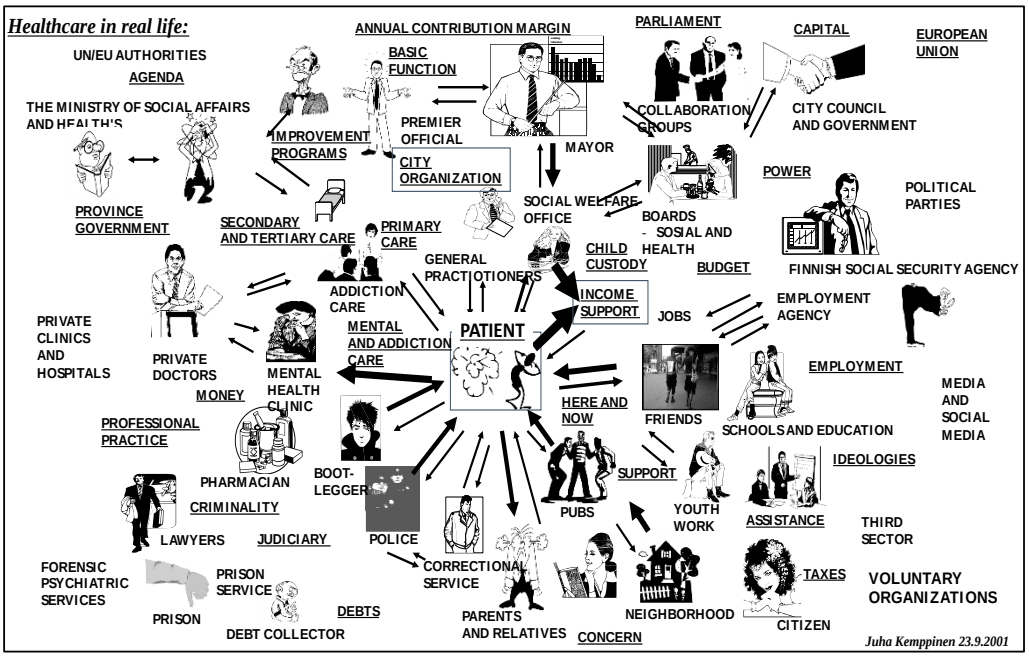

Figure 1: Health care environment in real life.

Mental health and substance use disorders have been the leading causes of years lived with disability (YLDs) and disability-adjusted life years (DALYs). These disorders caused 183,9 million disability-adjusted life years (DALYs) or 7,4% of all DALYs worldwide already in 2010. The burden of mental and substance use disorders increased by 37,6% between 1990 and 2010 as a result of population growth and aging, not of an increase in disease incidence or prevalence (Whiteford et al. 2013, 1575). Rehm and Shield stated: "Mental and addictive disorders affected more than 1 billion people globally in 2016. They caused 7% of all global burden of disease as measured in DALYs, and 19% of all years lived with disability." (2019, 10). Parikh et al. (2019, 333) remarked that "depressions were the most disabling of all illnesses monitored," according to the World Health Organization in 2017. The costs of mental health problems and alcohol dependency for the Finnish society are eleven billion and five billion, respectively, each year (OECD 2019).

Current health care systems in developed countries have not been specifically designed to meet the needs of health care (Vuori 1995, 1996; Parkin 2012; McColl-Kennedy et al. 2017). They have evolved primarily as unplanned and uncoordinated "add-ons" to the

existing culture of organizations, resulting in modern complex, dysfunctional, siloed, and fragmental systems (Middleton and Roberts 2000, 4; Fausz et al. 2019; Storm et al. 2019). Dissatisfaction with complacent and self- satisfied health care systems has increased (Porter and Olmsted-Teisberg 2006; Nance 2008; Gawande 2010; Kenney 2011; Makary 2012; Berwick and Hackbarth 2012; Edmond et al. 2014; Kriegel et al. 2016; Berry 2019). The voice of customers or patients has been forgotten almost entirely (Griffin and Hauser 2013; Coulson-Thomas 1998; Brownlee 2008; Seddon 2008; Topol 2015; Storm et al. 2019). The skyrocketing costs of health care, aging population, and increasing awareness of the quality defects of health care have questioned the present way of delivering care (Porter and Olmsted-Teisberg 2006; Porter 2010; Priyan 2017; Papanicolas et al. 2018). In his famous book "Out of the Crises", Deming (2000, ix) declared in regards to the failure of business: "The basic cause of sickness in American industry… is failure of top management to manage… pure and simple bad management." Several unsuccessful and costly solutions have been implemented to revise these shortcomings of healthcare (Martin 2012; Demir 2014). One contemporary managerial fad after another has failed to solve the strategical, operational, and tactical problems of health care (Vuori 1996; Middleton and Roberts 2000; Seddon 2008; Parkin 2012; Martin 2012). Finally, stakeholders have become frustrated with the well-known and prominent daily problems of health care, e.g. overcrowded emergency departments, poor accessibility and long waiting lists for appointment times, and the inefficiencies between handoffs in different care providers in the entire care path of the individual patient (Lillrank et al. 2004; Porter and Olmsted-Teisberg 2006; Wright and King 2006; Champy and Greenspun 2010; Eriksson et al. 2011; Inozu et al. 2012; Worth et al. 2012; Lillrank 2018; Balan et al. 2018; Storm et al. 2019) . Thus, there is an urgent need for a better system of delivering health care generally, and mental health and addiction care specifically.

Health care has started to acknowledge the difficulties in the healthcare business and benchmark real success stories of other business sectors (Nance 2008; Gawande 2010, Kenney 2011; Makary 2012; Torkki 2012; Torkki and Lillrank 2013). At the same time, there is still considerable suspicion about the suitability of manufacturing business solutions (for example BPM, business process management) for health, psychiatric, and addiction care (Allcorn et al. 1996 about the human cost of a management failure; Coulson-Thomas 1998 about health care as HPR, hospital process reengineering; Seddon 2008 about specifications, regulations, and targets worsening performance in public services ; Wachter 2015 about digitalization and "wiring the healthcare").

Porter and Olmsted-Teisberg (2006, 381) maintained that "healthcare is on a collision course with patient needs and economic reality. Without significant changes, the scale of the problem will only get worse. Rising costs, mounting evidence of quality problems, and increasing numbers of Americans without insurance are unacceptable and unsustainable". The authors forecasted that "the current organization of hospitals and physician practices around traditional specialty departments will evolve into integrated practice units" (2006, 383). They highlighted examples from the health care system of the United States. No one is happy with the current system – not patients, not employers, not physicians and other providers, not health plans, not suppliers of pharmaceuticals and

medical devices, and not governments (Porter and Olmsted-Teisberg 2006, 1–2). Therefore, the similar problems of the current design system of health care have been and still are common to many stakeholders in different countries (Britnell 2015).

Medicine is ranked among the highest valued professions in societies (Lappalainen 2018). The autonomy of the physicians in planning and delivering their practice has been almost untouchable. A common belief has been that the experts of medicine know best how to deliver care to patients. However, as the famous German psychologist, Kurt Lewin (1945) said: "Experience alone does not create knowledge." Vissers and Beech (2005, 5) pointed out one of the main difficulties in health care management is a ´dual management´. The dual management is fuzzy shared management responsibilities between clinical professionals and administrative staff and business managers without clear job descriptions. Similarly, Vartiainen (2009, 176) highlighted that dual management increases the ambiguity and complexity of a health care system. Reynolds et al. (2018, 622) called dual management as "nested systems of general system theories". Also, the decision-making of health care organizations is weakened and clouded by the different and usually conflicting interests and ambitions of clinicians, administrators, and politicians (Lillrank 2018).

Furthermore, hospitals and specialized clinics are thought to be very safe and efficient places. This experience-based illusion vanished when the report "To Err is Human" from the Institute of Medicine (IOM) was published in 1999. The report stated that, e.g. tens of thousands of people die of unnecessary infections. Liberatore (2013, 601) cited the report: "… around 98,000 patients die following medical errors in hospitals each year". Makary reminded (2012, 3) of the NEJM article of Landrigan in 2010: "As many as 25 percent of all patients are harmed by medical mistakes." In his book, Makary continued on the dangers of the current system of health care: "Medical mistakes are the fifth leading cause of death in the United States. The number of patients killed by preventable medical errors every year is equivalent to four jumbo jets crashing in every week." Shimizu et al. (2018, 1) claimed that ´diagnostic errors´ account ´more than 5%´ of medical adult outpatient care and ´contribute to approximately 10 % of all deaths´. The report stated that the solution is not to work harder. Thus, processes and process-based health care organizations need to develop to better meet the standards and quality of practicing health care (Repa 2011).

Many stakeholders, and especially employees in health care businesses, consider the abovementioned criticism on inefficient and ineffective health care unfair. Most of them are busy doing their daily tasks and activities in health care service systems. They are firefighting complex issues in their daily health care chores. Avoiding unnecessary accusations toward the profoundly committed health care professionals, who are trying to do their best, Nance (2008, vii) pointed out that "it is not bad people, it is bad systems. Fix those systems! Fix the systems if you want to stop medical mistakes and injuries". Both the IOM report of 1999 and the following report with similar results in 2004 admit that progress has been slow (Nance 2008; Kenney 2011). Nance reminded that, at the same time, commercial aviation, nuclear power, and chemical manufacturing have had

amazing success in increasing the safety of their plants. The checklists (Gawande 2010) in surgical operations are one example of new kind of thinking and the new culture in hospitals.

As Inozu et al. (2012, 4) stated: “The problem with and the solutions to the healthcare crisis are not about people nor technology nor science. They are about transforming the system. Fifty percent of 2.3 trillion dollars spent per year on healthcare in the United States wasted because of inefficient processes. Therefore, the answer is to fix the system of inefficient processes.” There is no health care system better than all others (Britnell 2015; Lillrank 2018). Similarly, Shrank et al. (2019) stated that the US health care, which are using most resources for health care, includes 25 percent of waste. Fausz and Howell (2019) mentioned that hardly anyone knows how much an ordinary medical procedure costs exactly, as there is no transparent price list for common medical procedures. A common opinion on the solution to the problems of health care system agrees with Inozu et al. (2012, 2–7) who maintained that the solution is not working harder nor spending more resources on the inefficient processes of health care.

The IOM report, according to Chaudhry (2008, 85), claimed that “the health care system requires a fundamental redesign, a transformation in which existing modalities are replaced by new paradigms for care delivery”. Similarly, Kotter (2011, 1) pointed out a general purpose of reorganizing organizations: “to make fundamental changes in how business is conducted in order to help cope with a new, more challenging market environment”. The IOM report, “Crossing the Quality Chasm: A New Health System for the 21st Century”, motivated the redesign of the current health care system and its culture to align better with the needs of patients. The report encouraged the adoption of a complex systems thinking mindset, which includes systems thinking, complex adaptive systems, and adaptive design (Widmer et al. 2018, 630). Thus, considerable opportunities to develop health care and its processes were available. The IOM report (2001, 67) presented “Simple Rules for the 21st Century Health Care System” (Figure 2).

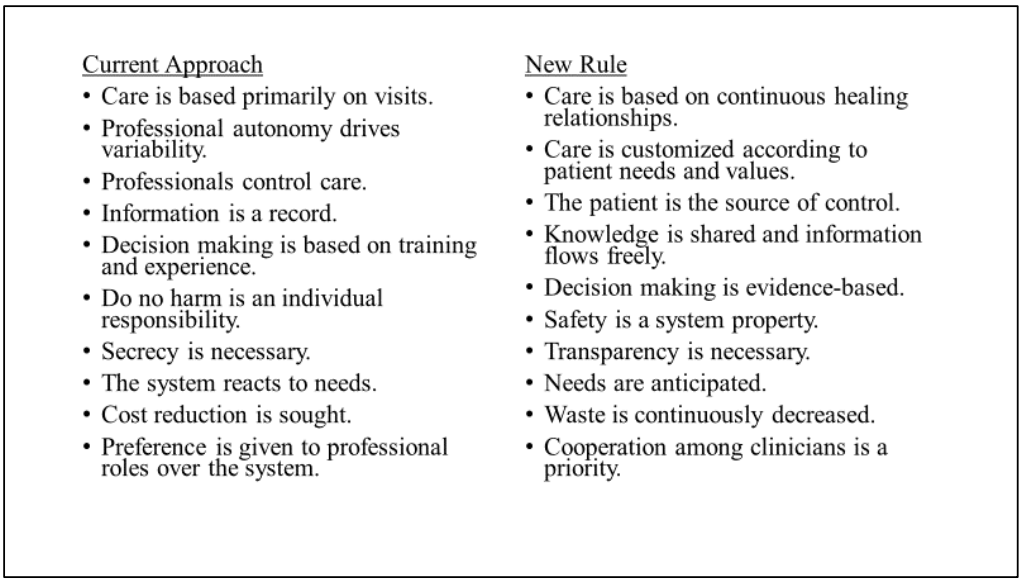

Figure 2: Simple Rules for the 21st Century Health Care System (The IOM report, 2001, 67).

But as Chaudhry (2008, 85) pinpointed that there is a substantial consensus ´the need for a fundamental redesign´ but no unanimity about the transformation nor the implementation a new system. Most people are believing ´expanding the use of information technology´. In health care organizations, the organizational focus must change for the benefit of the process focus. Harrington (1991, 1) wrote: “Health care costs are out of control.” He claimed to change “your way of thinking, acting and talking” (ibid. 5). He proposed to focus, instead of organizational structures, on the processes which control customer interfaces. He also warned that changing the orientation to processes is a difficult cultural change. The organizational culture shift from organizational focus to process focus is mandatory if fundamental changes in health care systems are to be reached.

Harrington (1991, 5) depicted the differences in organizational and process focus in organizations (Figure 3).

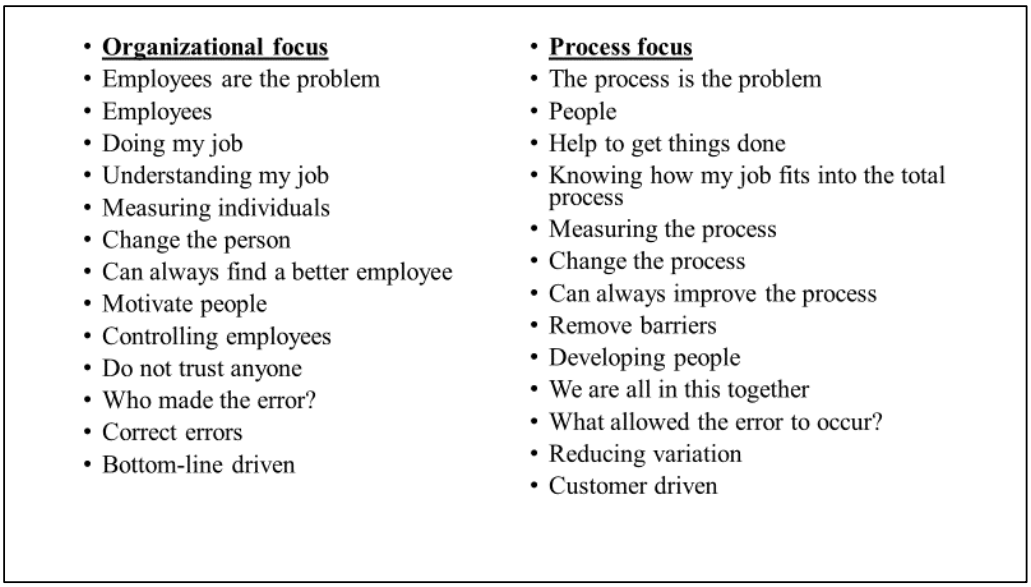

Figure 3: Organizational and process focus (Harrington 1991, 5).

In Finland, health care delivery problems are familiar and similar to those occurring in the United States and other developed countries. The current health, psychiatric, addiction and social care have not been systematically and intentionally designed for their current purposes in Finland (Vuori 1995; Eriksson and Arnkil 1995, 2; Chalice 2010, 39–40; Widmer et al. 2018, 631). In the 1990s, the national centralization of mental health plans was converted into a municipal obligation to provide sufficient services for mental health, but no exact definition for "sufficient" was given (Lehtinen and Taipale 2000). There was not even a commonly accepted and administratively suitable definition for mental health care which municipalities could apply. Nor was there an exact definition of what "functionally integrative services" meant, which the Mental Health Act (1116/1990), Public Health Act (66/1972), and Specialized Medical Care Act (1062/1989) referred to (Harjajärvi et al. 2006, 14). Thus, the municipalities in Finland could and still can independently decide what "sufficient demand and supply of mental health care" means in their area.

The psychiatric and addiction care service systems have evolved over the following years according to each municipalities own activities and several national and regional projects (for example MASTO, KASTE, MIELI, MERTTU) (Harjajärvi et al. 2006; Patana 2014). In addition, they have adopted their current form of the service design and processes by prioritising the needs of the employees, not the patients or the customers. As Kenney (2011, 6) posited: "… the [health care] industry had grown up around the caregiver, not the patient". Many decisions about health, mental, and addiction care have been made under the continuous pressure of economic situations. In the 1990s, it was decided that

mental health care was to focus on decreasing inpatient treatment and simultaneously increasing outpatient care. The former happened, while the latter did not at all, because of a deep economic recession in Finland in the 1990s (Harjajärvi et al. 2006). The deinstitutionalization trend of psychiatric inpatient beds in South Karelia in the south-east of Finland presents a common trend in Finland. The deinstitutionalization of South Karelia is presented in Figure 4.

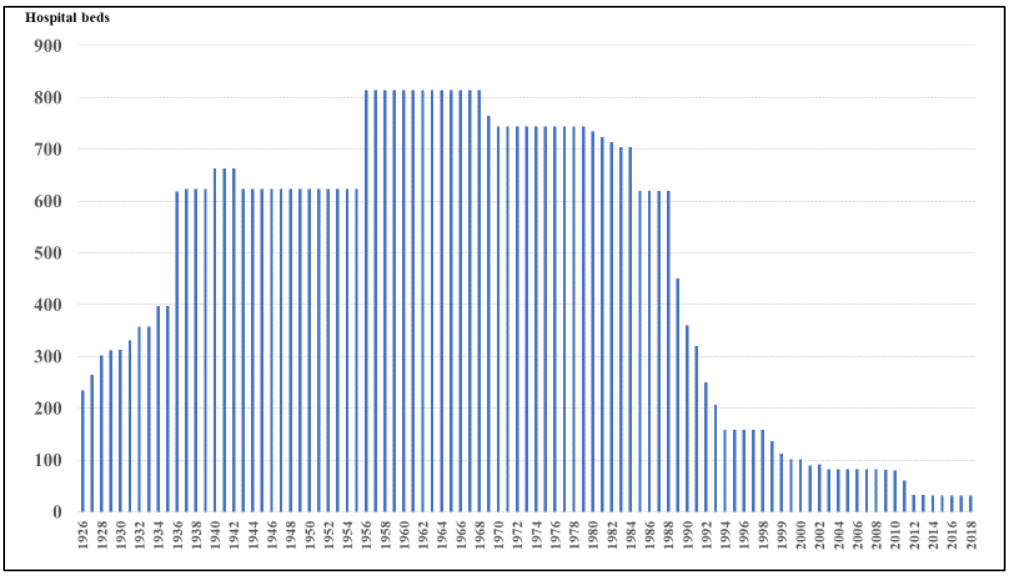

Figure 4: Mental hospital beds (adult, adolescence, and children) in South Karelia in 1926–2018.

The new law, The Mental Health Act of 1991, set priorities for mental health treatment in outpatient care, voluntary enrolment, and patient independence. The economic recession years and the deinstitutionalization of psychiatric inpatient beds happened, but not at the same time – as planned – as the development of outpatient care. Thus, outpatient care was arranged by local resources, which led to substantive variations in care resources and provided service systems (Ala-Nikkola 2017).

Mental and addiction care have been located in their own administrative, differentiated, and functionalized silos. A recent trend in Finland has tried to integrate these services and social services (Wahlbeck et al. 2018). Patana (2014, 26) explained the background of the first integration of mental and addiction care – at strategy plan level - in Finland: “The National Plan for Mental Health and Substance Abuse Work 2009–2015 (MIELI) was published in February 2009, after which the National Institute for Health and Welfare (THL) was given the responsibility of preparing the implementation plan. The plan consists of 18 propositions regarding the joint development of mental health and substance abuse work until 2015. Four main areas were identified: “strengthening the

status of service users; investing in prevention and promotion; organizing mental health and substance abuse services into a well- functioning set of services; and developing steering tools" (Moring et al. 2011)."

Vartiainen (2009) claimed that the problems of planning and developing a health care system can be explained by the ambiguity and complexity of the health care system. Citizens have not been able to articulate their needs for the dynamic circumstances of a specialized and hierarchized health care system. She proposed that redesigning and reforming health care is better understood and solved by complexity thinking. Unfortunately, as Rusoja et al. (2018) and Wilkinson et al. (2018) claimed, complexity thinking has not properly crossed the classical problem of rigour and relevance of scientific thinking. It is still more about theorizing than practicing, and more about theories than tools to solve.

Psychiatric and addiction care have been organized separately and locally (Wahlbeck et al. 2018). The stakeholders of neither psychiatric nor addiction care have a proper and systematic way of collecting and publishing data. The 'big picture of social and health care' has not been depicted nor described. Traditionally, the Nordic health care systems have plenty of collected but usually disintegrated data. According to the famous business management adage of James Harrington (1991): "Measurements are key. If you cannot measure it, you cannot control it. If you cannot control it, you cannot manage it. If you cannot manage it, you cannot improve it. It is as simple as that." In a similar vein, Spitzer (2007, 257–260) stated that the problem is that most organizations lack critical enablers of performance measurement. Furthermore, Patana (2014, 39) explained the same phenomenon: "Due to the fragmented service provision system, there is regional variation among the providers of these services, so nation-wide data on them is not systematically available." Disintegrated data is the predominant circumstance in health, mental, and addiction care. The worst situation in this instance is in social care in Finland, where production statistics usually do not exist at all. This is particular to the economic situation in Finland, where about 60 percent of collected taxes are spent on social and health care.

The current complex, dysfunctional, and fragmented mental and addiction care and their processes have known root causes for many existing problems faced in health, mental and addiction care, and also in social care (Wahlbeck et al. 2018; Storm et al. 2019). Current health care is full of problems previously faced in the manufacturing industry (Harrington 1981; Deming (1982/2000); Kotter 1996; Senge 1990/2006; Nelson et al. 2002, 2007; Lillrank et al. 2004; Champy and Greenspun 2010; Martin 2012; Wachter 2015; Lillrank 2018; Fausz and Howell 2019; Storm et al. 2019): unperceived and unmapped organizational processes, many unnecessary non-value activities, and inefficient handoffs in the entire care processes of an individual patient or customer.

Lillrank (2018, 2) pointed out that massive demand for health care services creates mass production: "High volume production must use division of labor, specialization, and standardization." Insofar, he stated that mass production of health care creates fragmentation and organizational silos, which managers are trying to solve by integrating

and connecting the silos to “seamless patient journeys”. “Healthcare is struggling with conflicting logics, craft and mass production, patient preferences and medical expertise, and professionalism and managerialism” (Lillrank 2018, 2).

Suman et al. (2014, 45) pointed out a common problem of optimization and suboptimization in an organization: “Most companies are divided into sectors, departments, sections, with managers perceiving their segment of organization as an entity itself, so they try to improve and optimize only their segment of organization (sub-optimization), which leads to more damage than benefits. Optimization implies defining the best balance for the complete system or organization, while sub-optimization connotes optimizing a part of the system without guaranteeing the improvement of a whole. What is crucial in the centre of system thinking of an organization are the relationships and connections within the organization and between the organization and the environment.”

Also, Worth et al. (2012, 51,77) asserted that ´delays, defects, rework, and firefighting´ denote about ´a broken process´, which has quality problems, nonvalue activities, and unnecessary costs. Juran (1951) called these kind of quality problems ´hidden factory´.

Similarly, Inozu et al. (2012, 14) posited that current health care processes have broken processes. The process steps are not depicted and planned properly. There are too many handoffs and decision points. The constraints are not disentangled. They continued: “Deming saw this situation repeated over and over again across many industries. He cautioned against reaching for the quick fix or Band-Aid but rather encouraged a walk through the entire process.” The adage of the famous Deming is this: “If you cannot describe what you are doing as a process, you do not know what you are doing.” Also, Michael George (2003, 36) explained that “typical process cycle efficiencies in services run about 5 %, meaning that work spends 95 % of its “in-process” time just waiting.” Many of the patients in health, psychiatric, and addiction care are so-called “work-in-process” patients (George 2003; Lillrank et al. 2004; Peltokorpi and Kujala 2006; Kujala et al. 2006). The WIP “work-in- progress” working style is, unfortunately, a dominant way of managing different projects in health care. The WIP-patients are patients whose care has been started in some way, but most of the time they are waiting for something else to happen in their care path. The process and systemic thinking offer tools to resolve these inefficient handoffs, complexity, dysfunctionality, and fragmentation issues in health, mental, and addiction care.

Increasingly, process management is an emerging philosophy to tackle the challenges of mental and addiction care. Hammer and Champy (1993/2001) presented the idea of a process-based organization, “Business Process Reengineering” (BPR). They maintained (2001, 2–3) that reengineering provides several successful business ideas: a single person to perform all the steps of a customer service request, collocated crossfunctional teams to perform the whole order fulfilment, building products for actual customer orders, no forecast of demand, and low-cost items procured by people who need them, not by a company’s purchasing department. Praveen Gupta (2007, 124) stated: “The design process is the most influential process in an organization... also the process that is the

least measured". He depicted (Figure 5, the Pareto figure) the most general factors which influence the costs of the enterprise the most.

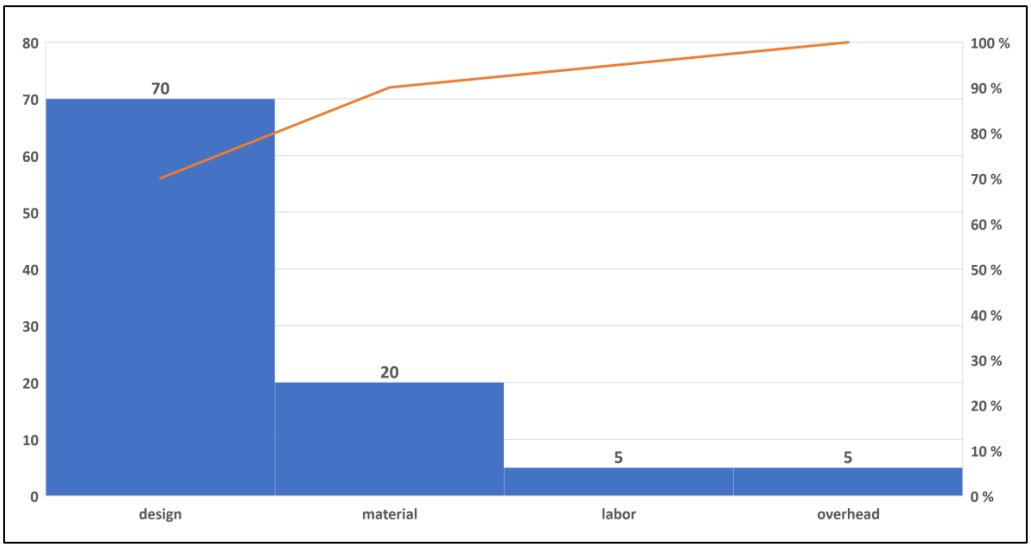

Figure 5: The cost factors of an organization with the highest impact (Gupta 2007, 124).

Similarly, Bohmer (2009, 2) highlighted that less attention has been paid on the design and management of the processes and organizations that compose a health care delivery system. Bohmer summarized the delivery process problems of health care. Doctors (and other health care workers also) 1) did not always know what to do, 2) when they did know, they did not always do it, and 3) when they did do it, they did not always do it right (Bohmer 2009, 24). Nelson et al. (2007, xxxii) stated that "the health care system is seriously flawed". The health care system does too much (overuse), too little (underuse), and wrong (misuse). They proposed to improve the health care system "from the inside out", designing quality by "a clinical microsystems approach". They argued that by focusing full attention on the front lines of care – the small clinical units (where care is actually made) – transforming the health care system is possible.

Also, Markus et al. (2002, 185) claimed: "Organization design is a critical process in every organization." He stated that it is closely associated with performance metrics ('productivity, cost, quality, and cycle time'). Similarly, Brussee (2012, viii) highlighted: "Production problems are best solved in the design phase." Also, Lillrank (2012, 8) stated in health operational management sense, that although health care service processes cannot standardized in similar exactness as in manufacturing industry, they can be design 'into coherent flows' (Vissers and Beech 2005).

Processes and process thinking are valuable tools to capture the problems of modern reality in mental and addiction care (Balan et al 2018). Laamanen and Tinnilä (2009, 52)

summarized process thinking as follows: “The core belief in process thinking is that there is a certain chain of activities to produce the most value for the customer. This value needs to be managed, and the process produces the operative result.” According to Laamanen and Tinnilä (2009, 52): “Process management is founded on the basic question of how an organization creates value for the customer. The core belief of process thinking is that value is created for a customer (aka a patient) in a chain of events, which can be called a process.”

Modig and Åhlström (2016) claim that the current use of health care resources has failed. They maintain that the dominant strategy of allocating health care resources is wrong. The most conventional way, the resource efficiency principle, is one of the main faults of the modern health care system. Booking every appointment separately with every employee in a team is not the best way to create an agile and smooth care path. In their famous Lean Thinking book, they stated that the flow principle of the care of patients has been forgotten or has not been successful in adapting to health care. According to the flow principle, all appointments of all stakeholders in patient care should be synchronized to enable as lean a patient care process as possible. Furthermore, Repa et al. (2016, 689) stated that in traditional hierarchical organizations the crucial processes and their supply chains are not easily seen which prevents fully ´exploit the possibilities of the technology progress´. Porter (2010, 2481) also stated: “The failure to prioritize value improvement in health care delivery and to measure value has slowed innovation, led to ill-advised cost containment, and encouraged micromanagement of physicians’ practices, which imposes substantial costs of its own.” Porter and Olmsted-Teisberg (2006, 4) coined the term ´value-based health care´ which means ´value for patient´, instead current zero-sum competition where ´the gains of one system come to the expense of others´.

The rise of process-based organizations and scientific management in health care have not been welcomed by everyone. Hartzband and Groopman (2016, 106) claim that “medical Taylorism” does not apply to all medical diagnoses nor to every care situation. They posited that scientific management and its measurements could eliminate important moments of truly facing the patients and their suffering. Ritzer (1983) warned about “the McDonalization of society”: The rationalization and bureaucratizing of society and social change in the ideas presented by Max Weber has substantial shortcomings; demands for rationality – efficiency, predictability, calculability, substitution of non-human for human technology and control over uncertainty – may lead to irrationalities produced by that ‘rationality’. Among others, he predicted the rise of the overweight of people because of fast food and pollution of nature based on rational acgiculture demands for fast growth. Ritzer and Miles (2019) continued that the age of digitalization is making the consequences of rationalization ever worse. As the consumption by digitalization increases, social relations, individuality, and diversity decrease, or are even destroyed.

However, literature on process thinking especially in mental and addiction care and their delivery is still scarce. Current textbooks on psychiatry (Saddock et al. 2017; Tasman et al. 2015) or addiction medicine (Ries et al. 2014) hardly even mention the word “process” in regards to process thinking or process-based organizations. Fortunately, the existing

gap in process thinking and process-based organizations in current psychiatric literature is diminishing. This dissertation pursues to present in more detail the process thinking and process development efforts (Repa 2011) for turning traditional separated and fragmented psychiatric and addiction care outpatient clinics into integrated mental and addiction outpatient clinics within the context of south-eastern Finland in 2011–2015. The clinic was called the MTPA model.

The reports of the Institute of Medicine (1999; 2001) presented some quality problems in US health care. The reports proposed to use health information technology (IT, including clinical decision systems, CDS) to mend the shortcomings in quality. Nevertheless, since 2004, the adoption of IT-solutions to health care has been slow. Similarly, health information technology has been recognized as a means, not an end, in efforts to diminish the quality defects. The electronic medical records (EMR) and computerized provider order entry (CPOE) assisted the accessibility and legibility of information. However, significant improvements in the quality of health care required proper implementation and use of clinical decision systems (CDS) (Berner 2009, 4).

Considering psychiatric decision making, Cosh et al. (2017, 970) mentioned that "research exploring decision making in mental health remains limited, especially in real-world psychiatric settings". Also, Bhugra et al. (2011, 404) stated: "Despite an increasing volume of research into medical decision making, our understanding of the processes underlying psychiatric decisions making remains limited." This dissertation is not about the popular shared decision-making concept in psychiatry (Drake 2009), nor computational psychiatry in silico (Erdi et al. 2017). This dissertation is about designing and providing, if not optimizing, at least satisfying solutions for constant wicked, unstructured problems in health, mental, and addiction care. The key processes of the integrated mental and addiction care outpatient clinic were innovated by the clinical decision support system (CDSS) artifacts. The clinic was developed in process-based organizations.

Thus, in this dissertation designing and implementing CDSS for natural, real-life problems and a real-life working place (an integrated mental and addiction care, the MTPA clinic) is an effort to improve the processes, flow, face-offs, and quality of the care of mental and addiction care patients. In practice, the goal is to accomplish the primary function of care: deliver value for the patients.

1.2 Objectives and research questions

Process thinking, systems thinking, and the process-based organization development approach are the focus of this dissertation. These approaches are applied to designing, developing, and establishing a new integrated mental and addiction outpatient clinic, which was named the MTPA model.

The dissertation has two primary objectives: (1) to develop various CDSS-assisted critical processes for an integrated mental and addiction outpatient clinic, and (2) to examine the

possibilities of increasing the productivity of these critical processes in an integrated mental and addiction outpatient clinic. Both the critical process development by CDSS and critical process productivity efforts offer a rarely studied view of process thinking and process-based organization approach in psychiatry and addiction medicine.

The objectives of the dissertation have been divided into three research questions. The first two research questions are linked to the first objective of developing the CDSS-assisted critical key processes in the MTPA model. The second and third research questions are linked to examining the possibilities to increase the productivity of the critical key processes in the MTPA model.

The research questions of this dissertation are:

Research question 1 (RQ1): What are the key process characteristics of the three key processes in integrated mental and addiction care?

- What are the key process characteristics of a new adult ADHD process?
- What are the key process characteristics of a resource-demanding multi-professional process, i.e. a psychiatric working ability assessment process?
- What are the key process characteristics of a process consuming the most resources, i.e. an opioid substitution therapy process?

Research question 2 (RQ2): How is it possible to support process development by redesigning or re-engineering business processes with clinical decision support systems (CDSS) in integrated mental and addiction care?

Research question 3 (RQ3): How is it possible to improve the productivity of each new critical key process in integrated mental and addiction care?

Publications I, II and III focus on the first objective of the dissertation. They present the three created CDSS-assisted critical processes in the MTPA model: the adult ADHD process, the psychiatric working ability assessment process, and the opioid substitution therapy process. Publications IV and V focus on the second objective of the dissertation and present an old business process management approach – reengineering or redesigning – as a tool for developing the processes in the MTPA model. Publication VI focuses onto the second objective of the dissertation and introduces an application of the theory of constraint (TOC) and a five-focusing step (5FS) solution, also called constraint management, as one organizational development theory to improve productivity and efficiency in the adult ADHD process.

Figure 6 summarizes the dissertation objectives and research questions, and demonstrates which publications answer to which research questions. The first objective of this dissertation was to develop clinical decision support systems (CDSS) to assist in implementing and establishing a new integrated mental and addiction care clinic (MTPA). The second objective was to examine the possibilities to increase the productivity of the

key and other processes in a newly established clinic. The research questions focused on developing the CDSS-assisted key processes, redesigning business processes, and increasing the productivity of the newly established clinic (MTPA).

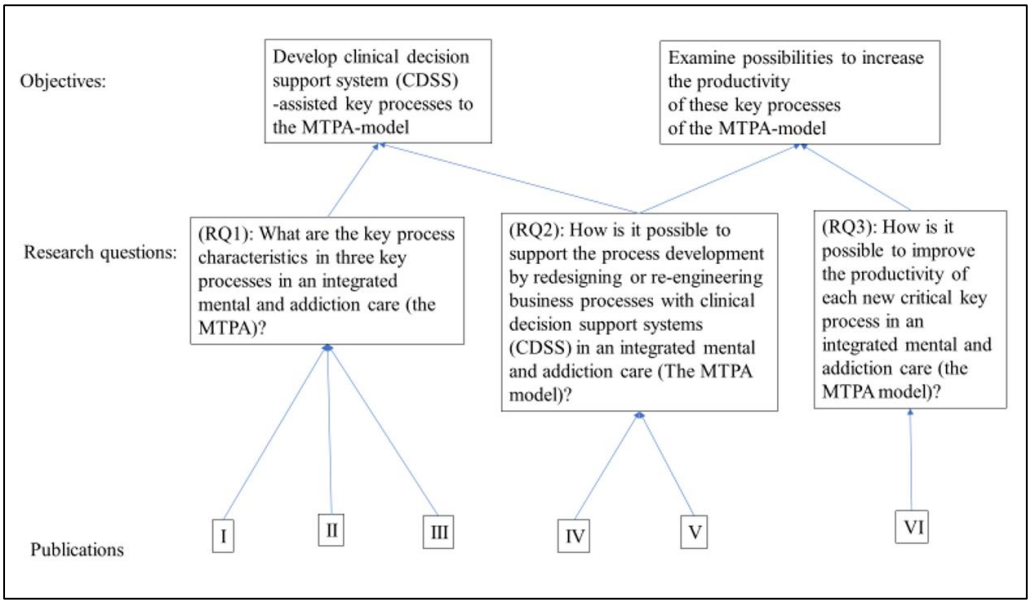

Figure 6: Objectives, research questions and publications.

1.3 The scope and positioning of the research

This dissertation concentrates on designing, developing, and establishing efficient and productive critical processes in a newly established integrated psychiatric and addiction care outpatient clinic. The design, development, and implementation of efficient and productive critical processes were achieved by designing innovative artifacts (software, CDSSs) and solving the efficiency and productivity problems of newly designed processes. This dissertation focuses solely on the first implementation in Lappeenranta, but the two other cases provide comparison and background knowledge and experiences for the dissertation. This dissertation endeavour can be presented as a Venn diagram (Figure 7) consisting of three broad research areas: systems sciences and IT systems, organization development, and systems and process thinking. This dissertation attempts to combine the perspectives of the three large scientific areas. Figure 6 shows how design sciences artifacts, systems and process thinking (Lean Six Sigma, Theory of Constraints and key process thinking), and the implementation of new processes are intertwined. The dissertation focuses on the intersection of these perspectives. Also, it presents a scope of the dissertation.

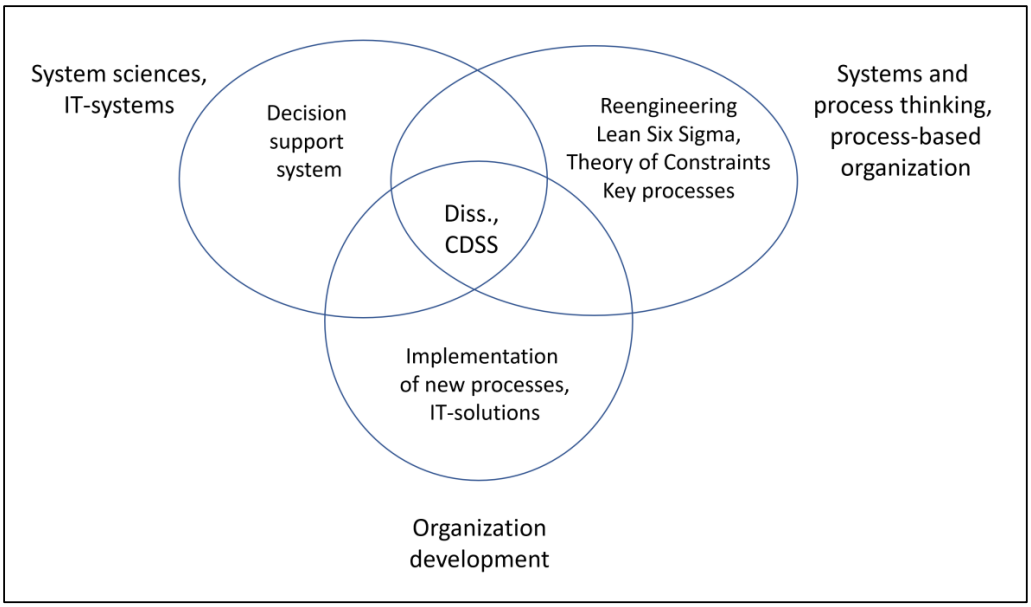

Figure 7: The scope of the research.

Manufacturing plants have been organized to function efficiently for about 100 years (Shewhart 1939; 1986). The same organizational development has been adopted in health care in the past forty years (Seddon 2008). Kemppinen et al. (2017, 19) reminded about the wicked processes of social and addiction care: "In the literature of productivity and efficiency, it has been stated that the working environment of social and health care is unique, complex, turbulent, and stochastic in its processes. Thus, the measurements of productivity and efficiency borrowed from the manufacturing industry do not fit comfortably in social and health care." (Linna et al. 2006; Gomes et al. 2010; Tolf et al. 2015).

Several attempts to solve severe current problems in health care have been executed in these organizations (Nance 2008; Gawande 2010; Kenney 2011; Grunden and Hagood 2012; Britnell 2015). According to Chalice (2010, 38–39), in health care, continuous quality improvement (CQI) has failed because it has not been implemented widely or continuously throughout organizations nor has it involved most health care employees. Total quality management (TQM) failed because employees did not understand it, nor was it implemented continuously throughout the organization. The motivation for both approaches was to align with the requirements of the Joint Commission for Accreditation of Healthcare Organizations (JCAHO). Some researchers have studied the reasons for organizational failure (for example, Hammer 1990; Hammer and Stanton 1995; Seddon 2008; Champy and Greenspun 2010; Lillrank 2012; Garicano and Rayo, 2016). Champy and Greenspun (2010, 71–72) summarized that the main reasons for failure were: 1) failing to engage the end-users early in the implementation of change and 2) ignoring "the

reality of how real work needed to change". Also, Pandza and Thorpe (2010, 183) described that "management practice is characterized by a variety of organizational phenomena with different degrees of manageability". Torkki and Lillrank (2013, 279) reminded: "Management is not an exact science that could deliver predictions; such as if you do A, then B will happen". De Feo (2017, 51) concluded that leading change in organizations "can be a perplexing and challenging undertaking". In leading change, Kotter (1996, 182–186) highlighted the "mental habits of lifelong-learning".

Several management models have emerged to solve common problems and challenges in different organizations (Nelson et al. 2007; Champy and Greenspun 2010; Inozu et al. 2012; Van den Berg and Pietersma 2015; De Feo 2017). Juuti (2018, 31) stated that, in practice, it is impossible to apply all organizational and management doctrines. These doctrines and tenets include several interdependent incoherences. Academic journals of organizational studies have been divided into subgroups preferring either academic rigor or practical relevance, and thus favoured parochialism, narrowing their focus on their own silos (Daft and Lewin 2008). Non-academic managers and leaders usually complain that academic journals do not have their daily chores as an asset (Winter 2008). One of the management doctrines, design science (DS) as a managerial science, tries to determine what might work in an organization, not why it works (Pandza and Thorpe 2010, 172). Also, design science research (DSR) aims to solve unsatisfactory issues in real organizational situations by developing artifacts that are one of the main outputs of DSR. Pandza and Thorpe (2010, 173) reminded that "artifacts, in contrast to natural systems, always fit their environments imperfectly".

At the beginning, design science was called "improvement research", and it was not aimed to simply increase the academic knowledge base. Design science also tried to build useful artifacts and construct IT artifacts, which could directly improve the researched world (Baskerville 2015, xxxv). In this dissertation, design science has been selected because it focuses on solving practical problems in real-life situations. Furthermore, design science outputs (artifacts) can be used to solve some common managerial and operational practice problems in health care. As Dresch et al. (2015, 3) pointed out, the design science "artifacts were designed and created to effect some change in a system, solving problems and allowing for a better performance of the system as a whole". The artifacts of design science also have a prescriptive (not an exploratory, descriptive, or explanatory one) nature in problem-solving which aligned easily with the development of the clinical decision support system. In this dissertation, these invented, developed, and implemented artifacts were the clinical decision support systems (CDSSs), which were used in the Serena platform.

Wilkinson et al. (2018, 607) stated that "health problems are rooted in complexity". They posited that health has been viewed through "a complex systems lens" over the last twenty years. The complexity of health has increased systems thinking, complex adaptive systems, and systems science. They maintained (ibid, 607) that: "Systems thinking draws from many disciplines and is composed of various theories including but not limited to complexity theory." Furthermore, De Feo (2017, 50–51) stated that an organization is an

open system which must be managed in the system's terms. Any change, even a little one, impacts the whole system and the interrelations of all of its parts. Without systems thinking and systemic involvement, suboptimization will occur. A systematic approach is needed to ensure organizational change. He maintained that "organizations will not change until the people in them change". The active participation of all employees guarantees change. He warned that "functional change alone is not sufficient to transform an organization". The structural changes of an organization without systems thinking can increase organizational problems. He also highlighted that "a bright idea for a change does not, by itself, make change actually happen". Dennis (2006, 17) stated about Lean transformations in organizations that they "most often fail because people have the wrong mental models". He pinpointed that Lean tools are important, but the way of thinking and management system behind the tools matters more. He also stressed (ibid., 26) that: "Anyone can make a plan; but deployment is the hard part."

Lean Six Sigma (Furterer 2009; Cohen and Dahl 2010; Arthur 2011 a, b; Shaffie and Shahbazi 202; Sperl et al. 2013: Morgan and Brenig-Jones 2014; Voehl et al. 2014; Brook 2017) is a systematic organization development approach which focuses on removing waste (defects, overproduction, transportation, waiting, inventory, motion, overprocessing, underutilized employees, and behavioural waste) and decreasing variation from organizational activities. In this dissertation, the Six Sigma approach was only a background ideology because of unreachable and disintegrated data. The Lean principles were applied to remove waste from the developed organizational processes in the focus groups when depicting the key processes of the integrated mental and addiction care clinic.

The theory of constraints (TOC) (Goldratt and Cox 1984; Goldratt 1990; Dettmer 1998; Cox and Spencer 1998; Wright and King 2006; Cox and Schleier 2010; Techt 2015) suggests that "all systems are similar to chains – or to networks of chains. Each chain is composed of a variety of links differing primarily in their strength, or capability. In any independent chain, there is one link – an only one – that is weaker than all the rest: the weakest link. This weakest link limits (defines) the maximum performance of the existing chain. In other words, the weakest link is the constraint to system performance." (Dettmer 1998, 11–12) In any organization, the system's constraint is the pacesetter for the entire system (ibid., 16). Goldratt (1984; 1990) developed a five-step method for breaking the constraints of the system: 1. Identify the constraint; 2. Decide how to exploit the constraint; 3. Subordinate everything else to the decision in step 2; 4. Elevate the constraint; and 5. Go Back to Step 1, but avoid inertia. In this dissertation, the TOC and the Five Steps of Focusing were applied to the developed key processes to increase the performance of the processes in the clinic.

Designing health care and its complex processes is a challenging endeavour. Bohmer (2009, 87–88) depicted the development of different health care processes and the effects of the stages of knowledge on health care operationalization. He stated that the term "health care delivery" is something of a misnomer -– health care delivery is not a well-defined product or service. There are some well-defined care processes, but "much health

care remains an emergent process of repeated testing and serial reconception" (Bohmer 2009, 88). He reminded that unstructured or semistructured health problems of patients lead ´an experimental repeated search than a production process´. He suggested that health care, in reality, has two different health care processes: the iterative and the sequential care processes.

The iterative care process is "a customized and unprogrammable search; the new- product development process (each patient as a new project) with repeated hypodissertation testing through design-build-test cycles" (Bohmer 2009, 88). The sequential care process is a highly programmed sequence of known steps "closer to the notion of "delivery" and more like "a manufacturing process in which a well-defined product or service is built to specification" (Bohmer 2009, 88). He also pointed out the complexity of care when the same patient can have both kinds of care processes at the same time. The iterative care process "discovering solutions to unstructured and semistructured problems through repeated search cycles is the essence of science. Iterative processes are the application of the scientific method to the care of an individual patient. A cause of and solution to the problem is hypothesized for each patient, data collected (either a diagnostic test or trial of therapy) and analyzed, and the hypodissertation confirmed or denied" (Bohmer 2009, 89).

The sequential care process is more like solution implementation, more a production process than science. Also, Bohmer (2009, 88–90) highlighted that the iterative and sequential care processes are designed and operationalized differently. The former is closer to emergency health care, the latter to elective health care. He emphasized (Bohmer, 107–108) that "over time, health care problems become more highly structured, clinician's solutions develop from unstructured trial and error to guided probe and learn, and finally to the simple application of codified rules and algorithms" (Figure 8). Thus, eventually like an attempt at prescriptive knowledge and a technical rule in design science, "at the highest stages of knowledge, a (care process) problem is solved by the application of a highly specified rule" (Bohmer 2009, 108).

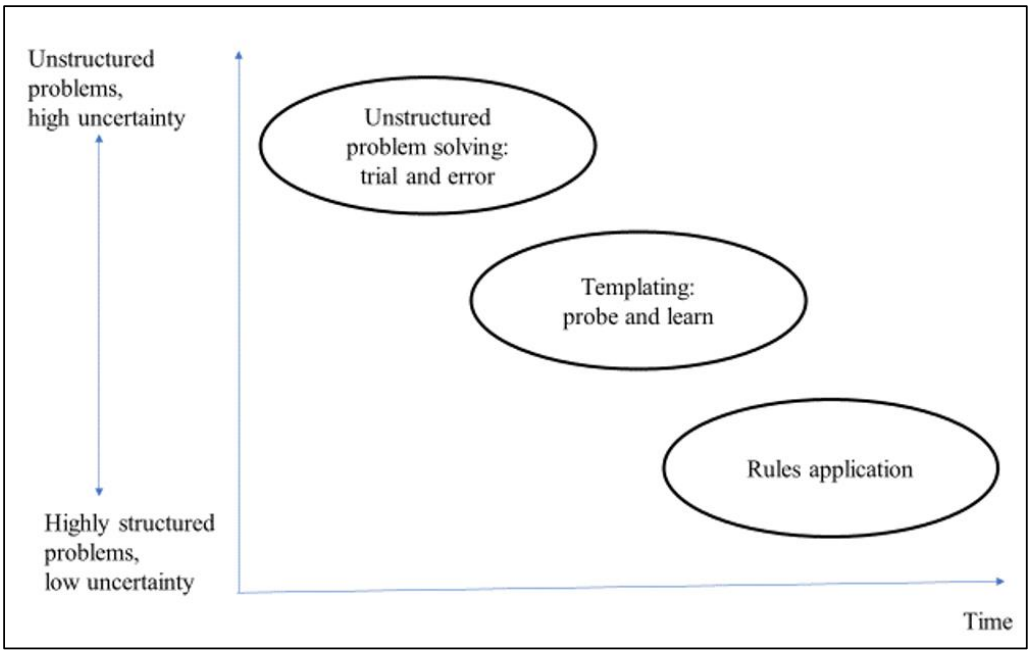

Figure 8: Evolving approach to health problem solving (Bohmer 2009, 108).

Worth et al. (2012, 2) advised that the starting point to perfecting patient journeys is to identify, understand, and improve the value streams in an organization. They stated that it is essential to depict the flow of interconnected, interdependent activities and processes. In addition, the Institute of Medicine (IOM, 2001) has emphasized that health IT systems should be designed to make it "easy to do the right thing". The IT-solutions meant to develop organizations offered the best possible way to reach prescriptive knowledge and a technical rule (Winter 2008; Berner 2009; Dresch et al. 2015) for a new team and a new clinic which integrated mental health and addiction care. The challenges of developing an organization and its processes, in general (Egolf 2001), and the implementation problems faced in similar enterprises, the focus group approach, and the designing CDSS IT-solutions were chosen. The clinical decision support system (CDSS; Berner 2009; Hagiwara et al. 2014) offered a comfortable, easily understandable, and iterative vehicle to implement the rule of "doing the right thing" for the first time in a new team and clinic. The CDSS-assisted key processes of the clinic formed an agile, efficient, and productive way to reorganize and implement psychiatric and addiction care operations

1.4 The structure of the dissertation

The dissertation consists of two parts. The first part consists of an introduction and overview of the research. The second part consists of the individual publications. Figure 9 illustrates the structure of the dissertation. The dissertation structure is as follows:

chapter one consists of an introduction, which explains the common background and motivation for the research. Secondly, theoretical foundations of the dissertation are presented. Previous literature on management science and clinical decision support system is presented.

Also, the theoretical framework of this dissertation is presented in the second chapter. Thirdly, research design, philosophical foundation, design science research, methodology, and the setting and background of the dissertation are presented. Fourthly, the results of the dissertation, a summary of the individual publications and their results, and the redesigning endeavour of the MTPA model are introduced in chapter four. Finally, in chapter five, the conclusions evaluate the scientific and practical contributions of the research. Also, the last chapter assesses the value of the research and renders suggestions for further research.

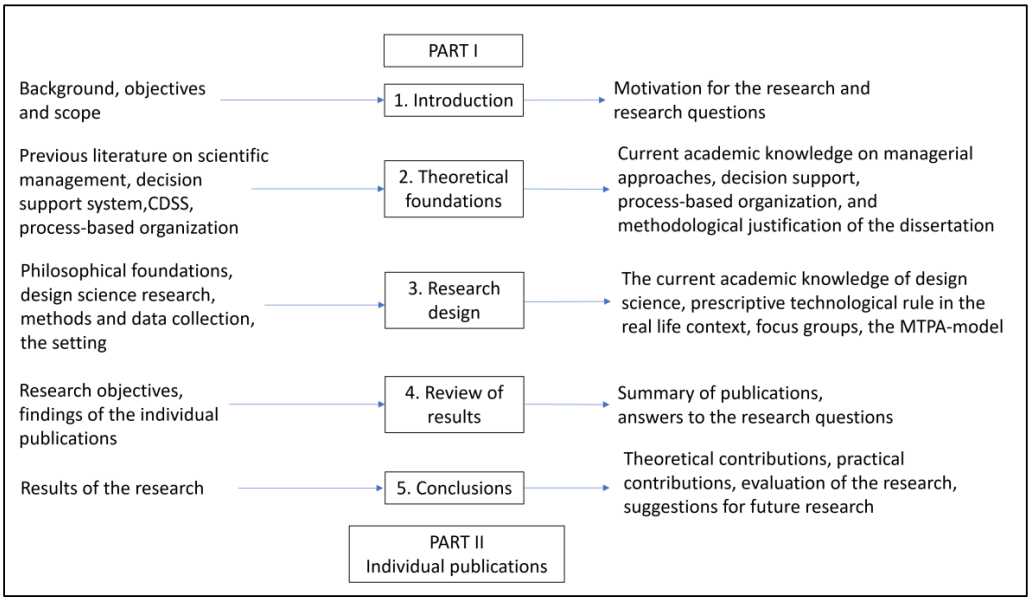

Figure 9: The structure of the dissertation.

2 Theoretical foundations

The theoretical foundation of this research is presented in this chapter. The history and development of scientific management and its connection to the decision support system (DSS) is shortly introduced. The choice of the scientific management principle and the background thinking to develop the clinical decision support system in this dissertation is shortly introduced. The emergence of executive information system (EIS) and group decision support system (GDSS) is described. The decision support system (DSS) and clinical decision support system (CDSS) in health care and medicine are depicted. The use of CDSS in psychiatric and addiction care are explained. The theoretical underpinnings of this dissertation are summarized.

2.1 Decision support systems

The beginning of the scientific management era changed the management of factories during the Industrial Revolution in the 1880s. The father of modern scientific management, Frederick Winslow Taylor, invented the observation, measurement, analysis, and improvement of work methods. In his book, The Principles of Scientific Management (1911), he explained his scientific management principles: "1) development of science for each element of work, 2) scientific selection and training of workers, 3) cooperation between management and employees, and 4) responsibility shared equally between workers and management" (Ozcan 2017, 2). Ozcan (2017, 2–3) summarized the historical background and development of decision techniques. Table 1 presents the development of scientific management and decision techniques, which have been complemented and modified with the articles of Dantzig (1982, 2002).

The chosen management approaches for developing a clinical decision support system in a new clinic in this dissertation were: reengineering (Hammer 1990, 1996, 2007; Hammer and Champy, 1993; Davenport 1993; Laine and Tiirikainen 1994; Hammer and Stanton 1995; Hammer and Champy 2001, 2003, 2006; Champy and Greenspan 2010), the principles of the Lean Six Sigma (LSS; Arthur 2011a), and the theory of constraints (TOC).

Reengineering means "starting over" (Hammer and Champy 2006, 34). Hammer and Champy stressed that it "does not mean tinkering with what already exists or making incremental changes that leave basic structures intact" (ibid., 34). Reengineering means to abandon "long-established procedures and looking afresh at the work required to create a company's product or service and deliver value to the customer" (ibid., 34). More formally defined: "Reengineering is the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service, and speed" (ibid., 35).

Table 1: The development of scientific management and decision techniques.

Years	Authors	Assets
1911	FW Taylor	Scientific Management
1910–1920	Frank and Lillian Gilbreth	Standardisation
1910–1920	Henry Gantt	Psychological impact on work conditions, A time-based display chart to schedule work
1915	FW Harris	Quantitative inventory management
1930s	W Shewhart	Statistical sampling techniques for quality control
World War II	GB Dantzig	Operation research methods, project management techniques
1950s	(1823 Fourier; 1911 de la Vallee Poussin) 1936 T Motzkin, 1928 and 1937 J Von Neumann, 1939 L Kantorovich, 1932 W Leontief, TC Koopmans	Linear programming, queuing methods
1970s	IBM	Computers, management information system (MIS)
1980s–1990s	1983 A Feigenbaum, 1985 K Ishikawa and Lu, US Navy, 1991 Harrington, 1995 Hammer and Stanton	Total quality management (TQM), Continuous Quality Improvement (CQI), Business Process Reengineering (BPR), Business Process Management (BPM)
2000s	1982 K Oliver, 1990 Hammer, Toyota Production System (TPS), 1991 Womack and Jones, 2007 Hammer, 2016 Modig and Åhlström	Supply chain management (SCM), productivity improvement techniques (Business Process Reengineering, Lean Management)

The LSS is a combination of Lean thinking (reduce waste from processes and simplify the work area) and Six Sigma (reducing variation and eliminating all defects and deviation from processes). “The essence of LSS is to build a better, faster, cheaper, and more profitable process” (Arthur 2011b, xiii). Arthur stated (ibid.) that the LSS helps to simplify, streamline, and optimize processes.

The underlying assumptions of the theory of constraints (TOC) are: (1) all systems are simple, if understood correctly, (2) there are no conflicts, in reality, just different perspectives of reality, and (3) people want to do good. The third assumption is especially correct in health care. It is often the system or people's perspective that forces them to behave in ways that are against their intuition (Goldratt and Cox 1984/2014, 1990; Cox and Schleier 2010; Wright and King 2006, 2010; Techt 2015). Also, the TOC states that every system has constraint(s), which has a significant impact on the lead time or the throughput of the system. Techt claimed that the term "constraint" originates in Systems theory (Techt 2015, 17). Goldratt (1990, 4) defined: "A system's constraint is… anything that limits a system from achieving higher performance versus its goal." Goldratt (1984; 1986; 1990) presented the five-focusing steps (5FS) to identify and take actions at the performance limiting constraints of the overall system. Techt (2015, 15) proposed that the theory of constraints helps "make changes and investments only in the areas where they are absolutely necessary" and pinpoints the areas where to use more 'labour-intensive methods' (LSS, TQM, JIT). In managerial sense, reengineering, Lean Six Sigma, and the Theory of Constraints were combined with information technology (IT) to develop clinical decision support systems (CDSS) in this dissertation.

Ozcan (2017, 3) highlighted: "Information technology (IT) has become integral to management decision processes." The advancement of IT-technology and computers gave hope that they might support the incomplete and inefficient decision- making of human beings. The very concept of a decision support system originates from the article of Gorry and Scott Morton (1971/1989, 52) where they combined the thoughts of Anthony (managerial activity into three categories: strategic planning, management control, and operational control) and Simon (problem-solving activity: intelligence, design, and choice). They renamed Simon's concepts of programmed and nonprogrammed problems as structured and unstructured ones. They named unstructured decisions and their supporting information systems the "Decision Support System" (DSS). In his article, Little (1970) laid the groundwork for DSSs for managers by supposing a decision calculus: "a model-based set of procedures for processing data and judgment to assist a manager in his decision making." He presented a model to extend the managers' ability to think about and analyse business operations. He set requirements for the decision calculus; it must be: 1) simple (easy to understand), 2) robust (it must give right and valuable answers), 3) easy to control (easy to tailor for one's own purposes), 4) adaptive (it must be updated), 5) complete in important issues (includes possibilities from both objective and subjective points of view), and 6) easy to communicate (easy to change inputs and quickly obtain outputs).

Shim et al. (2002, 111) defined the DSS as follows: "Decision support systems (DSS) are computer technology solutions that can be used to support complex decision making and problem-solving[…] A DSS defined as a computer system that dealt with a problem where at least some stage was semi-structured or unstructured" They explained that the DSS has evolved from "two main areas of research — the theoretical studies of organizational decision making (Simon, Cyert, March, and others) conducted at the Carnegie Institute of Technology during the late 1950s and early 1960s and the technical

work (Gerrity, Ness, and others) carried out at MIT in the 1960s." Porter et al. (2018) warned about the difficulties: "in order to […] adopt new technologies such as CDSS, implementation needs to be supported effectively at the organizational level".

Also, Hackathorn and Keen (1981, 21) defined DSSs as follows: "DSS are interactive computer-based aids designed to assist managers in complex tasks requiring human judgment. Such systems aim to support and improve a decision process." Furthermore, Marakas (2003, 6) posited that there is not such a thing as "a universal DSS" and continued that there "probably never will." He stated that a typical and useful DSS is designed for a narrow scope of problem-solving. Also, he maintained that a decision of significant magnitude needs several DSSs which must be coordinated to solve unstructured problems effectively.

Eom (2001) summarized the various definition suggestions of DSS (Alter 1980; Bonczek et al. 1981; Keen and Scott-Morton 1978; Sprague and Carlson 1982). He concluded "a DSS can be described as a computer-based interactive human– computer decision-making system that:

1. supports decision makers rather than replaces them;
2. utilizes data and models;
3. solves problems with varying degrees of structure: (a) non-structured (unstructured or ill-structured) (Bonczek et al. 1981); (b) semi-structured (Keen and Scott-Morton 1978); (c) semi-structured and unstructured (Sprague and Carlson 1982);
4. focuses on effectiveness rather than efficiency in decision processes (facilitating decision processes)."

In shortly, Velmurygan et al. (2008, 156) stated: "DSS is an umbrella term used to describe any computer application that enhances the user's ability to make decisions".

In categorizing the various types of the DSS, Hackathorn and Keen (1981) suggested one way of categorizing the decision support systems into three dimensions: personal, group, and organizational decision support system. Hackathorn and Keen (1981, 24) described that the personal support "focuses on a discrete task or decision which is quite independent of other tasks". Rockart and Treacy (1982) published an article about the executive information system (EIS) in the Harvard Business Review. The article "The CEO goes online" gradually influenced even the attitudes of old school executives and became favourable for executive information systems (EIS). As these writers wrote, it used to be mainly front-line workers and middle managers who used computers in their work in the 1980s. The writers hoped that the top executives would change from "verbally oriented" executives to "very analytic" ones, as they preferred top executives to use computers by themselves rather than sitting in several daily meetings to get information from their key personnel. Rockart and Treacy forecasted three incentives for the increased use of computers among top executives: 1) "user-oriented terminal service systems were

available at an acceptable price", 2) "executives were better informed of the availability and capabilities of these new technologies", and 3) "volatile competitive conditions heightened the desire among top executives for ever more timely information and analyses" (1982, 83). Stein (1995, 56) described the development and timing of the EIS: "1982- Systems designed for individual executives, 1987- Systems designed for teams of executives, and 1989- Systems support multiple levels of management". Wahlstrom and Wilson (1997, 75) studied the EIS users and placed them into three categories: 1) 'converts', 2) 'pacesetters', and 3) 'analysers' who used the EIS for "(1) organizational monitoring; (2) information access; and (3) organizationa understanding". Thus, George and Nunamaker (1992, 312) crystallized the personal support system and the goal of an EIS, which was "to summarize and integrate key information required by senior decision makers to more effectively communicate, plan and control their organization".

Secondly, according to Hackathorn and Keen (1981, 24), group support "focuses on a group of individuals, each of whom is engaged in separate, but highly interrelated, tasks". DeSanctis and Gallupe (1987, 589–609) laid the foundations for studies on group decision support system (GDSS) which evolved from "the need to improve group decision making". They maintained (1987, 589) that "GDSS combines communication, computing, and decision support technologies to facilitate formulation and solution of unstructured problems by a group of people". They argued (1987, 589) that the post-industrial society needed more knowledge, was more complex, and more turbulent. Group decision meetings became more frequent and more important, more confronting, and more complex. At the same time, group decisions provided more participation and a shorter time to achieve the decisions. He et al. (2014, 940) reminded that "GDSS is a subcategory of DSS". To summarize, Elfvengren et al. (2004, 279) stated: "The goal of a GDSS is to support a group in effectively cooperating and working together to reach its goals. The purpose of a GDSS is to support and develop the group decision-making process."

Thirdly, according to Hackathorn and Keen (1981, 24), organizational support "focuses on an organizational task or activity involving a sequence of operations and actors". George and Nunamaker (1992, 307) maintained that IT and organizational structure intertwined in the Leavitt and Whisler (1958) article "Management in the 1980s". The writers posited that Leavitt and Whisler (1958) coined the term "information technology" in their article. Leavitt and Whisler predicted many changes in organizations with the emergence of IT technology. George and Nunamaker (1992, 311) explained that the aim of the organization decision support system (ODSS) is to support organizations in "communication, coordination, filtering, decision making and monitoring". Nader and Chalal (2008) posited the role of ODSS, which is different form DSS, GDSS, and EIS (executive information system). The ODSS supports, organizes, coordinates and optimizes autonomous individual decisions and labor in organizational processes at the entire firm level.

Finally, Nemati et al. (2002, 144) forecasted that computer-based systems, DSS "are becoming increasingly more critical in the daily operation of organizations". They aid

decision making in ´various semi- to ill-structured problems´ in the organizations. In addition, Shim et al. (2002, 121) predicted the DSS future technology ("mobile tools, mobile e-services, and wireless protocols such as Wireless Applications Protocol (WAP), Wireless Markup Language (WML), and iMode") enables "ubiquitous access to information and decision support tools." He et al. (2014, 940) posited that "rapid advances in DSSs have spurred tremendous growth in the use of new theory and technologies such as Artificial Intelligence (AI) techniques, particle swarm optimization, fuzzy logic, agent grid, and visualization user interface (VUI).

Furthermore, Ykhlef and ElGibreen (2010, 247) stated that one data mining technology, called sequential pattern mining (SPM), searches for patterns and thus forms new knowledge from large databases. Unfortunately, SPM takes a long time to find rules from large databases. The Genetic Algorithm (GA)"is an evolutionary algorithm, which can be used to discover Sequential Pattern rules in a short time. GA is a general purpose search algorithm which uses principles inspired by natural genetic populations to evolve solutions to problems". Lately, DSS (decision support systems) have been used in various business management domains, for example energy policy (Aggarwala et al. 2018) and urbanization and climate change (Mahmoud and Gan 2018).

Summarizing the development history of the decision support system DSS, Arnott and Pervan (2014, 270) depicted (Figure 10) the general genealogy of decision support system research in business intelligence (BI) and business analytics (BA) during the past 50 years.

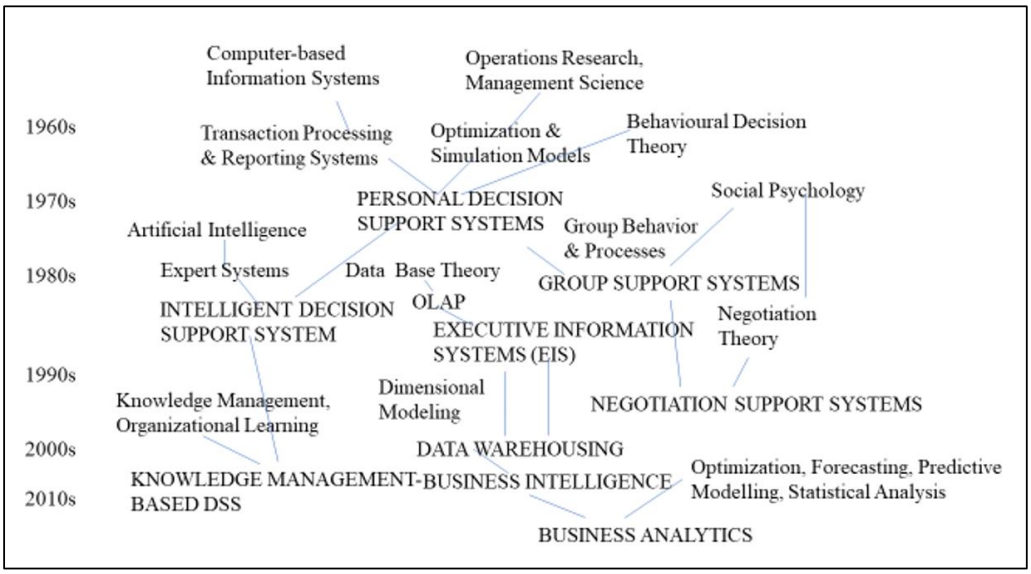

Figure 10: The genealogy of the DSS field in 1960–2010.

This dissertation focuses on the specific type of the decision support system: the clinical decision support system and its evolved use of CDSS in medicine and health care in general and integrated mental health and addiction care specifically.

2.2 Clinical decision support systems

"How people make decisions is an enticing enigma", admitted decision analyst George Menkov (2015, vii) and continued (ibid., vii) that "decision is indeed tricky to study". This dissertation focused on medical and psychiatric decision making generally and clinical decision making specifically.

Several books have been written about medical decision-making (for example Nagelkerk 2001; Montgomery 2006; Schwartz and Bergus 2008; Alfaro-LeFevre 2013). Montgomery (2006, 32, 34) stressed that medicine is, if it is a science, a science of individuals, which "Aristotle in the Metaphysics declared an impossibility". Furthermore, the assumption that it is possible to know everything about the diseases and injuries of an individual patient is "an unwarranted leap". She also stated that, while evidence-based medicine (EBM) promises such a future, it still cannot offer "complete information for every patient in each phase of any condition". She argued (ibid., 5) that: "No matter how solid the science or how precise the technology that physicians use, clinical medicine remains an interpretative practice." She continued (ibid., 5) that clinical judgment is a prerequisite for the success of medicine. She declared (ibid., 5, 33): "It is neither a science nor a technical skill (although it puts both to use) but the ability to work out how general rules – scientific principles, clinical guidelines – apply to one particular patient." Clinical medicine "is – to use Aristotle's word – phronesis (intellectual capacity or virtue), or practical reasoning. It enables physicians to combine scientific information, clinical skills, and collective experience with similar patients to make sense of the particulars of one patient's illness to determine the best action to take to cure or alleviate it." She postulated (ibid., 5, 33) that medicine is not a science in an old-fashioned Newtonian nor positivist sense. She summarized (ibid., 34) that "if medicine were a science in the old-fashioned positivist sense, its laws could be programmed, and diagnosis could be determined and choice of treatment decided entirely by computer." According to her, medicine is the phronesis, practical reasoning, or clinical judgment, that "enables physicians to fit their knowledge and experience to the circumstances of each patient".

Schwartz and Bergus (2008, xiii) stated that "decision making is a key activity – perhaps the key activity – in the practice of health care". They continued (ibid., xiii) that physicians do acquire vast knowledge, specialized skills, training, and practice, but "it is in the exercise of clinical judgment and its application to specific decisions facing individual patients that the outstanding physician is distinguished". They (2008, 13) concluded that "good decisions are characterized first and foremost by good decision process." They also stressed (ibid., xiii) that "a large majority of clinical decisions are variations of basic patterns of decision problems, … and amenable to the same basic classes of conceptual tools". Nagelkerk (2001, xi) pointed out that an episodic treatment

approach (instead of a holistic, patient-centred approach) often results in costly and fragmented care. She continued (ibid., xi) that "beginning practitioners [were] challenged to efficiently and accurately collect and evaluate clinical data, develop diagnoses, and formulate a therapeutic plan of care". She concluded that "clinical decision-making is a careful, deliberate process that is at times fraught with uncertainty".

Clinical reasoning and decision-making in medicine are elusive and complex. Therefore, De la Rosa Algarín (2011, 2) claimed: "Probability concepts are inherent in medical diagnosis because health care professionals can never give a 100 % accurate diagnosis." In a similar vein, Nikolaidis (2009, 3) explained one possible reason for the complexity of medical decisions: "[T]he concepts of fuzzy logic models of diagnostic reasoning (as physicians think about medicine and living organism) are vague, overlapping, and nonspecific … thus these concepts are lacking parametric accuracy required for calculating and analytic possibilities." Tversky and Kahneman (1971) proposed that two different mechanisms are in operation in human decision making: system 1, which is a quick judgment, and system 2, which a slower expert knowledge system (Menkov 2015, 56). Recently, Shimizu et al. (2018, 1) explained: "Dual process theory (DPT), popularized by Kahneman's book 'Thinking Fast and Slow,' has been widely discussed as a model for analyzing decision-making processes. The fundamental theory underpinning DPT is that the brain has a fast (system 1, non-analytical) and a slow (system 2, analytical) decision-making process. "The System 1 is "an intuitive, error-prone system" and the system 2 "a slower, energy-intensive but more thorough analytical system". Shimizu et al. continued: "In every clinical setting, cognitive errors made via the system one process."

In the medical and health care domain, CDSSs initially evolved from the article of Ledley and Lusted (1959, 10), who outlined the foundations of the medical diagnostic reasoning of a physician in mathematical terms. They posited that these foundations must be understood in order to increase the use of computers as a diagnostic aid. They maintained that physicians unconsciously apply three mathematical disciplines when making diagnoses: symbolic logic, probability, and value theory. They use symbolic logic to consider the combinations of symptoms (symptom complexes) with a combination of diseases (disease complexes). They use probability as a practical necessity to ponder the possibility of a diagnosis as a diagnosis is almost never precise. They use a value theory already expressed in the oath of Hippocrates – do not harm, primum non nocere. The value theory requires a physician to assess treatments within the constraints of ethical, social, economic, and moral issues when diagnosing and treating his patients. Thus, the writers computerized the medical diagnostic reasoning.

Ledley and Lusted (1959) summarized their article about computers as clinical diagnostic decision support. They explained that the mathematical techniques and the use of computers support in the CDSS, is not replace the increasingly complicated work of the physicians. They hoped that with the help of CDSS the physicians could "make a more precise diagnosis and a more scientific determination of the treatment plan." (Ledley and Lusted 1959, 21)

At the same time with Ledley and Lusted, Simon (1960) stated the following about decision-making: "An unstructured (or semi-structured) decision by definition cannot be programmed because its precise nature and structure are elusive and complex." Simon was interested in computers and artificial intelligence in the decision-making of organizations. Dantzig (1982, 44) reminded: "Before a computer can intelligently be used, however, a model must be formulated and good algorithms developed. To build a model requires the axiomatization of a subject matter field." Also, Montgomery (2006, 35) pointed out the difficulties of "computerizing" medical decision making that "solid attempts have been made in computer science to codify clinical expertise, but expert systems in medicine perform only at the level of a good intermediate practitioner and [are] no match for the expert". He (2006, 5) forecasted: "No matter how solid the science or how precise the technology that physicians use, clinical medicine remains an interpretative practice. Medicine's success relies on the physicians' (on multiprofessional teams capacity in this dissertation) capacity for clinical judgment."

In psychiatry, CDSSs have evolved from the end of 1960s. Bergman and Fors (2008) highlighted that "the DIAGNO system by Spitzer and Endicott was described [in]1968 as a computer program that simulated a DSM-1 diagnosis based on data from the psychiatric status schedule". Spitzer and Endicott (1968) presented their computer program, the DIAGNO, which was "based on a logical decision tree model similar to the differential diagnostic procedure employed in clinical medicine. The decision tree approach consists a series of questions, each of which is either true or false." Previous psychiatric computer models according to Spitzer and Endicott (1968) have been based on "various statistical models, which require knowledge or estimates of the base rate of occurrence of symptoms or signs for each diagnoses". Also, solid epidemiological information is required. Bergman and Fors stated (2008) that for the quality issues in psychiatry "methods such as the DSM (Diagnostic and Statistical Manual) are used to improve the patient interview process in order to gain more reliable information to support an effective and accurate diagnosis". In their own studies, they presented (2008) that the promises of the CDSS have not actualized in psychiatry: "… traditional paper and pencil methods were better than the tested CDSS and thus we conclude that CDSS for diagnostic procedures may interfere with diagnosis accuracy". However, Malhotra et al. (2017) presented that in one domain of psychiatry, telepsychiatry, the CDSSs could be a solution to the lack of psychiatrists in rural areas.

The current quality problems in health care and the improvement suggestion of the IOM report (2001) proposed the use of the CDSS for bettering the work of health care personnel. Concurrently, the CDSS evolved as one solution for the many previously described quality problems of health care (Bright et al. 2012; Seixas et al. 2014, 141). In addition, Haynes and Wilczynski (2010) and Kong et al. (2012) stated that CDSS could decrease the number of errors in health care. Seixas et al. (2014, 141) defined CDSS "as an important category of health information systems (HIS) designed to improve clinical decision-making". As Berner (2009, 4) referred: "Clinical decision support systems provide clinicians, staff, patients, and other individuals with knowledge and person-specific information, intelligently filtered and presented at appropriate times, to enhance

health and health care." He continued that the suggestion about increasing accessibility and legibility of health information, (also includes electronic medical records, EMRs, and computerized provider order entry, CPOE) have been since 2004 but a proper implementation of health IT have been slow. Also, Sim (2003, 599) pointed out incentives for CDSSs: "There is increasing interest in the use of CDSSs to reduce medical errors and to increase health care quality and efficiency." In a systematic review of CDSS, Garg et al. (2005) presented that the promises of the CDSS have not been actualized properly, and they posited that CDSSs have improved performance by 64 %, but only 13 % in actual patient outcomes. Thus, the CDSS could help "which includes computer-aided clinical knowledge management system".

Health policy efforts have been made to promote the use of computerized decision techniques. In the US, Roshanov et al. (2013, 2/12) wrote that "the Health Information Technology for Economic and Clinical Health (HITECH) act allocated 27 billion dollars for incentives to accelerate the adoption of electronic health record (EHRs). The act required that the computerized decision systems would meet "meaningful use" requirements which were "implementation of decision rules relevant to a specialty or clinical priority, drug allergy alerts, and provision of decision support at the point of care." They presented that the EHR use in office-based physician service systems rose from 48 % (2009) to 72% (2012). Also, they reminded that "financial penalties will result if the requirements are not met in 2015". Berner (2009, 5) summarized the history of clinical decision systems. The early versions of CDS system worked as an expert consultation for diagnosis and medication selection. The newer versions include multiple possibilities: general references, specific guidelines, nationally recommended guidelines, and suggestions and customized order sets for unique patients. The general development of the medical CDSS and their foci from the 1960s to the 2000s (Table 2) is outlined by Robert Greenes (2017, 163).

In terms of the system architecture of decision support systems (DSS), Marakas (2003, 8–9) shortly outlined a general structure of a DSS. He posited (2003, 8–9): "A DSS is not a simple system with common, identifiable characteristics and a singular or common purpose. […] [S]imply defining a DSS requires consideration of numerous factors including its intended purpose, the context within which it will be used, and its outcome objectives. Describing or classifying a DSS concerning its components poses an equally challenging task." He mentioned an early classification by Alter (1980), who divided the DSS components into seven categories: data analysis systems, representational models, optimization models, accounting models, suggestion models, analysis information systems, and file drawer systems. Furthermore, he suggested that Alter's classification can be diminished into two categories: a model-oriented and a data-oriented system. Finally, Marakas (ibid.) stated that the components of a DSS could be classified into five distinct parts: 1) the data management system, 2) the model management system, 3) the knowledge engine, 4) the user interface, and 5) the user(s).

Table 2: Major CDS Foci introduced by the decade (Greenes 2017, 163).

Decade	Major Foci Introduced
1960s	Early fascination with the computer as a diagnostician with exploration of Bayesian, and then in the 1970s also artificial intelligence/expert system methods. Collection of data on specific topics at particular points in the care process, as structured data entry or documentation templates.
1970s	Use of alerts and reminders for key notifications and actions.
1980s	A focus on guidelines and protocols for workup and management.
1990s	Organizing specific actions or sets of actions, as orders and order sets for use at appropriate points in the care process. Retrieval of context-appropriate information resources tailored to what the user is doing or is likely to want or need to know.
2000s	More recent approaches to population management seeking to provide information about most appropriate actions in particular care settings and to identify subgroups (of patients or providers) that need specific attention. Visualization and presentation approaches to support cognition and decision-making, e.g. as trends, graphs, animations, relationship maps, or other forms – typically through the applications and extensions to the user interface of EHRs

Harding and Redmond (1996) described the classical system architecture of the expert system (ES) as: 1) dialogue structure, 2) inference engine, and 3) knowledge base. The first structure, the dialogue structure, is the language interface to access the ES. The second one, the inference engine, will try to match, for example in a clinical decision support system, the entered symptoms to a certain rule-base, clinical guideline-based, semantic network, or other structure held within the knowledge base, to choose a particular diagnosis. The inference engine applies specific logical rules to the knowledge base to deduce new information. The third structure, the knowledge base, is according to Harding and Redmond (ibid., 91) “the heart of the expert system”. The knowledge base includes all the expert knowledge. Seixas et al. (2014, 144) structurally summarized the main components of one expert system, the CDSS (Figure 11), grouped them by their inference engines, and also provided some examples of the names of the CDSSs in medicine (Figure 12).

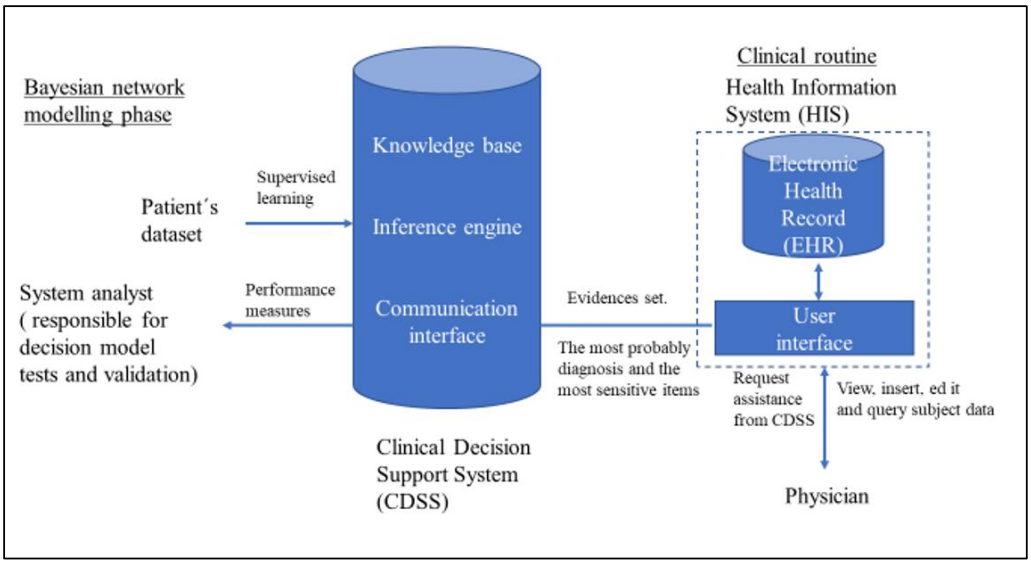

Figure 11: Clinical decision support system components.

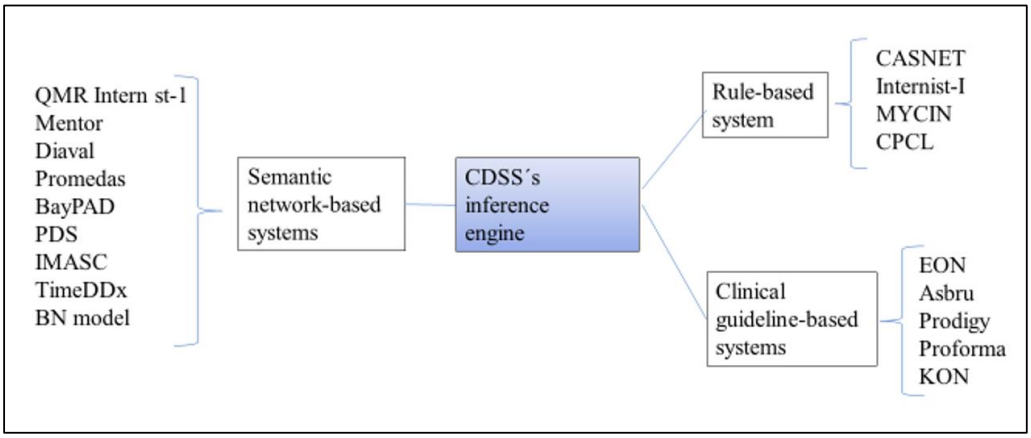

Figure 12: Clinical decision support systems grouped by their inference engine.

Considering the technical aspects of the clinical decision support systems, De la Rosa Algarín (2011, 1) depicted that there are two kinds of clinical decisions in medicine: diagnosis decision and diagnostic process. The former is about to “analyze data to determine the cause of sickness”. The latter,” diagnostic process, or management, decides which questions to ask.” Thus, he (2011, 1) stated that excellent decision-making requires three things: 1) accurate data, 2) pertinent knowledge, and 3) appropriate problem-solving skills. Accordingly, he clustered (De la Rosa Algarin, 1–2) clinical decision support

systems, CDSS into three categories: “1) Information Management Systems, for storing and retrieving clinical knowledge. The interpretation of such knowledge is left to the clinician, 2) Focusing Attention Systems, which alert the user of possible conflicts or problems that might have been missed, and 3) Patient-Specific Recommendation Systems, which provide a personal assessment of a patient, usually following simple logic rules.” Similarly, various CDSS types taxonomically categorized by Ramnarayan et al. (2002, 361) (Table 3) are used in clinical practice.

Table 3: The various CDSS types used in clinical practice.

Function	**Example of routine use**
Alert	Clinical-laboratory systems highlighting abnormal values
Diagnosis	Producing a differential diagnosis for paediatric rheumatic diseases
Reminder	Reminding the clinician to schedule an immunisation visit
Suggestion	Suggesting adjustment to adjust mechanical ventilation
Interpretation	Paediatric electrocardiogram interpretation
Prediction	Predicting mortality from a Paediatric Index of Mortality (PIM) score
Critique	Reviewing total parenteral nutrition prescriptions
Assistance	Assisting selection of optimal antibiotic choices in neonatal infections

Furthermore, De la Rosa Algarín (2011, 3) pinpointed the substantial set of requirements, which an excellent CDSS in medicine and psychiatry must satisfy: “These requirements … range from patient data (acquisition and validation of), medical knowledge (including its modeling, elicitation, representation, and reasoning), system performance to the integration in the clinician’s workflow.” He enumerated (De la Rosa Algarin, 3–13) some difficulties in meeting those requirements of a good CDSS:

1. “there is no coding system able to capture all the details of care given by clinicians”
2. “no coding system able to capture the subtle differences in a patient’s illness and medical history”, “several coding standards exist, but there is no standard of standards”
3. modelling medical knowledge is a difficult task, there is low (aka education) and high (aka experience) level medical knowledge which “needs to be modeled, elicited, represented and reasoned efficiently”

4. need for extensive and updated medical knowledge bases which continuously evoke useful, discerned, usable, and every time accurate information for a clinician
5. usability "of human-computer interaction, user-interface and input methods, and performance of the support systems themselves," aka CDSSs to seamlessly integrate into a clinician's workflow
6. the patient's role is a passive one
7. security and accessibility level issues.

The four system features of CDSS (Kawamoto et al. 2005; Hoyt et al. 2012, 69; Porter et al. 2018) have proved to improve clinical practice, and three of them were computer-based support. Graham et al. (2018, 824) showed which are the "key features of successful decision support tool implementation and improvements in care":

1. Automatic provision of support as part of a routine clinical workflow
2. Provision of clinically actionable information
3. Provision of data at the time and location of clinical decision-making
4. Use of a computerized tool, computer-based decision support.

When these four features exist, CDSS improved clinical care about 94% of the time (Hoyt et al. 2012, 69).

Borum (2018, 177) cited Osheroff (2009) about ´the CDS Five Rights´ (Table 4) of successful design and implementation CDS systems. He posited: "In sentence, "the CDS Five Rights, is the right information to the right people in the right format and the right channel at the right time." Borum (2018, 177) stated that "use of the CDS, Five Rights framework, can assist in determining optimal CDS system utilization, as well as identifying barriers to use".

Table 4: The CDS Five Rights (Borum 2018).

The CDS Five Rights	Examples
Right information	clinical knowledge, evidenced-based practice guidelines, clinical pathways, and clinical algorithms
Right people	people who need information for clinical decision making and consists of physicians, nurse practitioners, nurses, pharmacists, clinical staff, and patients
Right format	describes decision support interventions, such as alerts, data, prompts, order sets, and informational buttons
Right channel	the Internet, electronic health records, patient portals, workstations, and mobile technology systems
Right time	the timing of CDS in the workflow along with the right time to guide key decisions or actions

Thus, many obstacles to designing, implementing, and using computerized medical devices for health care have emerged and identified. Neither physicians nor patients have eagerly applied computers and their software in physicians' offices or hospitals. CDSS can easily break standard workflow, jeopardize professional autonomy, and human-computer interfaces are too slow, clumsy, and awkward to learn and understand. Kaplan (2001, 15) stated that systems for aiding clinical decision-making have been in existence for over 25 years, but they are not generally used nor widely clinically accepted. Kaplan posited that the evaluation of the CDSS lacked: 1) a naturalistic design to study actual routine CDSS use in clinical settings, 2) a theoretical basis for understanding the development and implementation of CDSS, 3) other users besides physicians, and 4) other medical computer applications (hospital information systems HIS, computer-based patient records CPR, and physician order entry POE). Also, Sim stated (2003, 602): "CDSSs is [sic] as much a process as a technological intervention. Thus, a CDSS's workflow requirements and impact are important for understanding its effects and its generalizability."

Also, similar to Borum (2018), Hoyt et al. (2012, 20) listed the barriers to health information technology adoption: inadequate time, inadequate information, cost, lack of interoperability, lack of training, lack of knowledge, change in workflow, privacy, legality, behavioural change, and health information technology hype versus fact.

Wright et al. suggested (2018, 503–504) several corrections for the CDSS practice:

1. “better tools and testing procedures for migration of CDS content are needed”
2. “a robust testing and monitoring strategy”
3. “pre-implementation testing and post–go-live testing and monitoring”
4. “better testing, build reviews, and easier-to-use build tools”
5. “clear formats for preparing specifications (in our experience, flowcharts work particularly well), design reviews, and multidisciplinary design teams”
6. “better communication processes between those responsible for management of terms and concepts and those responsible for CDS”
7. “more robust knowledge management tools and processes”
8. “additional research and development needed to ensure the reliability of these external systems and optimize their performance, particularly since several vendors are likely to be involved in their development and maintenance”
9. “Who is responsible for CDS maintenance? Provider organizations are ultimately responsible for their CDS content, we also believe that EHR vendors and content suppliers should provide tools for monitoring CDS in real time and enhancements to their content-authoring and knowledge-management tools”
10. “CDS developers and researchers to report these (malfunction) cases through our online submission form (https://goo.gl/o1klE2) and to consider preparing them as case reports for publication”, and
11. tools and procedures for detecting or, better yet, preventing CDS malfunctions.”

Thus, the final solution for computerized medical diagnostic reasoning and medical CDSS is still waiting to be discovered. The IBM Watson-project is one of the latest efforts in solving computerized medical diagnostic reasoning problems. Seixas et al. (2014) proposed the Bayesian Network (BN) to broaden the utility of the clinical decision support system (CDSS).

Furthermore, Kuo and Fuh (2010, 831) described a broader and more developed architecture of the CDSS. They integrated CDSS with HEALS (Health Examination Automatic Logic System, which forms also data repositories for CDSS), which includes clinical guidelines, expert consensus, system development of clinical experts and local experiences applied to the individual patient in hospital. Furthermore, they mentioned:” The output text of CDSS is composed of diagnoses, medical recommendations, and lifestyle recommendations for clinical disorders…Novice clinical workers using HEALS daily can take the output texts as references for specific domains.”

Also, Sadoughi et al. (2018, 209–210) forecasted that the future expansion of CDSS to HIE (Health Information Exchange) systems. They stated “the HIE is a fundamental solution to the problems related to disparate, fragmented and non-interoperable healthcare systems. HIE is defined as technology that electronically shares all patient’s clinical and

administrative information among health care institutions within a region, community and internationally between different systems." In conclusion, Liu et al. (2018, 825) putted forward that the expanded CDSS with new methods (data mining, machine learning, and artificial intelligence) and techniques (Internet of Things (IoT), cloud computing, and fog computing) enable collection the Personal Health Information (PHI) in various devices in 24/7/365- manner.

Surely, the future enterprise and ecosystem wide CDSS (Hoyt et al. 2012, 3), which includes all shareholders in the society at large (even social and employment authorities, local shops, gyms etc.) of the entire patient care process, will hold promises to solve many economical, quality, accessibility and other problems in the current systems of health care.

2.3 Summary and theoretical framework of the dissertation

For this dissertation, the motivating incentive was the frustrating inefficiency of health care, especially the fragmentation and siloes of mental and addiction care. Scientific management literature offered a historical evolution of what different management and leadership approaches have been applied to improve efficiency in different business areas over the decades.

Several promising tenets and doctrines attracted to review the ideas to improve efficiency in mental and addiction care. Initially, the reengineering of and ideas of redesigning health delivery care (Hammer 1990; Hammer and Champy 1993; Hammer and Stanton 1995; Hammer and Champy 2006; Hammer 2007; Champy and Greenspan 2010) unlocked the way from mental stagnation and status quo and promised a real, fast, and achievable organizational change. The Toyota Production System (TPS) (Womack and Jones 2003; Morgan and Liker 2006; Chalice 2010) highlighted the characteristics of an efficient production system. Lean Six Sigma thinking and Lean Six Sigma Green and Black Belt courses in 2013–2014 (Munro et al. 2008, 2015; Kubiak and Benbow 2009; Chalice 2010; Mahal 2010; Sperl et al. 2013; Brook 2014, 2017; Modig and Åhlström 2016) brought about available practical tools to develop health care organizations.

Finally, the ideas of business process improvement, streamlining processes (Harrington 1991, 2012; Lillrank et al. 2004; Laamanen 2009), and redesigning/reengineering organizational processes (Hammer 1990; Hammer and Champy 2006; Champy and Greenspun 2010) clarified the theoretical vision and strategy for business process improvement and encouraged the organizational development depicted in this dissertation.

The theory of constraints (TOC, a methodology to identify, exploit and remove the constraints in processes) and The Five-Step Focusing (5SF) (Goldratt 1984, 1990; Goldratt and Cox 1986; Techt 2015) offered the approach to achieve more productive processes. Initially, the tools of Lean Six Sigma (LSS) were meant to monitor the development of the processes. A further intent was also to use the collected data from the

processes in statistical process control (SPC, Oakland 2011) in order to develop controlled and capable processes. The ultimate aim was to develop and sustain mature processes during process integration. The lack and inaccessibility of complete integrate data of the organization hindered these efforts.

The design of care (Bohmer 2009) and design science (Simon 1969, Vaishnavi and Kuechler 2015; Dreschler et al. 2015) served as an inspiration to develop intrinsically complex health care processes to software artifacts of the core processes. The core process development and iteration occurred in the focus groups (Krueger and Casey 2015). Multiprofessional team efforts in key process development were implemented by an IT-assisted decision support system (DSS) in the Serena-platform. The key processes were transformed to the CDSSs. These new designed processes were based on the proper evaluation of the individual patient journey (planning an entire care path) with each member of the multiprofessional team. Thus, the use of CDSSs aimed to guarantee the efficient implementation of these newly developed processes. The CDSS-artifacts aimed to coordinate various human and other tasks, activities, and resources to achieve the best possible efficiency and operational excellence, as presented in health operation research, (hOM) (Vissers and Beech 2005). Furthermore, the contribution of CDSSs was to reduce common faults and failures (Kotter 1996) in implementing new changes (ineffective communication, indefinite work tasks and roles, inefficient face-offs, and inadequate view of entire care path).

Beer and Nohria (2000) stated that nearly two-thirds of organizational change efforts fail. A myriad of reasons has contributed to the failure of organizational change (Allcorn et al. 1996; Kotter 1996; Snedaker and Hoenig 2005; Seddon 2008; Champy and Greenspun 2010; Juuti 2018). Champy and Greenspun (2010, 104) warned about "starting a reengineering effort by trying to change how people think. It hardly ever works. Cognitive change just takes too long." They suggested (ibid., 104) instead to start with changing the way people work, which is the best way to change their thinking: "The faster you change how clinical work is done, the faster the behaviors of clinicians and their staffs will change." Thus, IT-solutions with clinical decision support system -artifacts were chosen.

Champy and Greenspun (2010, 92) stressed three requirements for a successful implementation of the IT-system in health care: 1) workflows must be carefully thought through, 2) the technology must be fully integrated into the health care-delivery system, and 3) the care providers must be fully trained in both the processes and the technology.

The road map of the plan for the establishment and development of the MTPA model (including the IT-software assisted key processes) is depicted in Figure 13, which presents the most essential theoretical management and decision support system underpinnings of this dissertation.

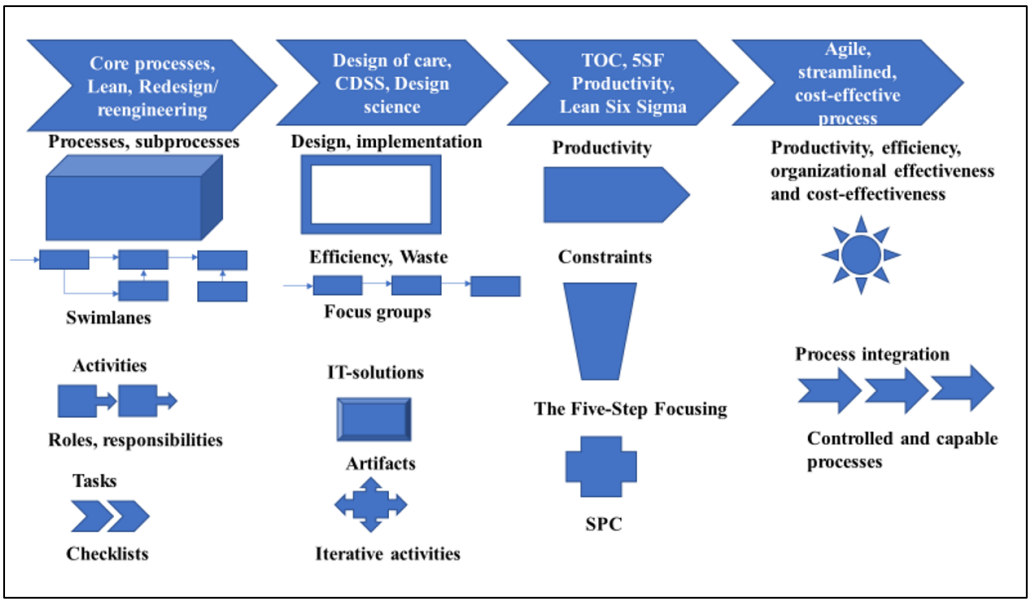

Figure 13: The theoretical framework of this dissertation.

3 Research design

In this chapter, the philosophical foundation, research approaches, the research method, and data (the CDSS assisted core processes) introduced. This research based on prescription-driven research in practical, real-life situations. The design science (publications 1, 2, 3, 4, 5, and 6) and theory of constraints (TOC) approaches (publication 6) are the methodological choices that allow innovative and flexible research methods studying the process development in various process levels.

3.1 Design science research

Design science and the design science research community is multiparadigmatic. Dresch et al. (2015, 13) wrote: "Herbert Simon first introduced the concept of Design Science in his book entitled "The Sciences of the Artificial," published in 1969." The emergence of design science has been stated to originate from criticism toward traditional sciences, for example, natural sciences and social sciences. The bibliography (Table 5) below lists some main assets of the design science authors in short.

Many researchers have also discussed the need for a solid ground of design science and design science research (1969 Simon, 1990 Nunamaker et al., 1991 Orlikowski et al., 1992 Walls et al., 1995 March et al., 2002 Markus et al., 2004 Baskerville, 2004 Hevner et al., 2004 van Aken, 2006 Gregor, 2007 Peffers et al., 2007 Gregor et al., 2008 Baskerville et al, 2008 Kuechler and Vaisnavi; 2010 Piirainen et al., 2011 Myers et al., 2014 Ostrowski et al., 2015 Dresch et al., and 2015 Vaishnavi and Kuechler Jr). Ostrowski et al. (2014, 443–444) stated the current state of design science research, although design science has accepted as a research approach. They emphasized that state of art of design science does not guide DS researchers about "consistent and comprehensive (research) phases, nor "choices of (research) techniques." They highlighted that the previous "DS methodological guidelines (Hevner 2004; Walls et al. 1992) are seldom 'applied'." The descriptions of necessary methodological activities (procedures, tools and techniques) are scarce. They concluded that "the existing methodology is insufficiently clear, or inadequately operationalised – still too high level of abstraction (Peffers et al. 2007)." Also, Piirainen (2010, 94) reminded the multi-paradigmatic nature of the IS field has ´an important gap´ considering "the underlying ontological and epistemological assumptions and methodological issues, such as validation of knowledge contributions."

Table 5: The bibliography of design science authors.

Year	Authors	Title	Main points
1969/ -96	Simon	The Sciences of Artificial (a book)	Laid ground for science of artificial, also for science of design; thus, design science
1990-91	Nunamaker et al.	Systems Development in Information Systems Research (an article)	Proposed the use of systems development as a methodology in IS research; that systems development is a valid and valued research methodology. Software engineering as the basic method of applying the systems development research methodology
1991	Orlikowski et al.	Studying Information Technology in Organizations: Research Approaches and Assumptions (an article)	Proposed a plurality of research perspectives to increase effectivity to study information systems phenomena; explained positivist, interpretative, and critical research perspectives
1992	Walls et al.	Building an Information System Design theory for Vigilant EIS (an article)	Defines an information system design theory to be a prescriptive theory which integrates normative and descriptive theories into design paths intended to produce more effective information systems; a design theory of vigilant information systems for EIS
1995	March et al.	Design and natural science research on information technology (an article)	Suggests a research agenda for the scientific study of IT, compares natural and design science
2002	Markus et al.	A Design Theory for systems that support emergent knowledge processes (an article)	Identifies a class of design problems we call emergent knowledge processes and addresses the design problem of providing IT support for emerging knowledge processes (EKPs). The TOP Modeler artifact developed. Examples of EKPs include basic research, new product development, strategic business planning, and organization design. Developed a new IS design theory for EKP support systems
2004	Baskerville et al.	Action Research in Information Systems: Making IS research relevant to practice (an article)	Explained shortly and concisely the principles of action research and role of action research in IS research
2004	Hevner et al.	Design Science in Information Systems Research (an article)	Informed the community of IS researchers and practitioners of how to conduct, evaluate, and present design science research; provides seven guidelines for IS researchers

2004	Van Aken	Management Research Based on the Paradigm of the Design Sciences: The Quest for Field-Tested and Grounded Technological Rules (an article)	The focus of the article was on the development of design knowledge, which occupies the middle ground between descriptive theory and actual application; design knowledge includes object, realization, and process knowledge
2006	Gregor	The Nature of Theory in Information Systems (an article)	Introduces five interrelated types of theory and examples of each: (1) theory for analysing, (2) theory for explaining, (3) theory for predicting, (4) theory for explaining and predicting, and (5) theory for design and action. Describes ways to classify theories
2007	Gregor	The Anatomy of a Design Theory (an article)	Identified eight separate components of design theories: (1) purpose and scope, (2) constructs, (3) principles of form and function, (4) artifact mutability, (5) testable propositions, (6) justificatory knowledge (kernel theories), (7) principles of implementation, and (8) an expository instantiation.
2007	Peffers et al.	A Design Science Research Methodology for Information Systems Research (an article)	The overall objective for the paper is the development of a methodology for DS research in IS. They outlined the components of the design science research methodology process
2010	Piirainen et al.	Quo Vadis, Design Science? – A Survey of Literature (an article)	The bibliometric analysis of the most influential design science literature
2011	Myers et al.	A Set of Principles for Conducting Critical Research in Information Systems (an article)	Presents the contribution of the ideas of some critical research thinkers in particular and critical thinking in general in IS research
2014	Ostrowski et al.	Ontology engineering step in design science research methodology: a technique to gather and reuse knowledge (an article)	Presents the ontology engineering process in the DS research methodology and provides pragmatic steps to follow the process
2015	Vaishnavi and Kuechler Jr	Design Science Research Methods and Patterns – Innovation Information and Communication Technology (a book)	A book explaining the basics and beyond in design science research
2015	Dresch et al. (eds.)	Design Science Research- A Method for Science and Technology Advancement (a book)	A textbook explaining the comprehensive approach to design science research

The philosophical foundations of design science are subsequently shortly presented. In an axiological sense (Vaishnavi and Kuechler 2015, 30; Simon 1969; Dresch et al., 2015, 68; Myers et al., 2011; Iivari 2007, 41), DS tries to solve real-life problems by creating prescriptive (Daft and Levin 1990; Walls et al. 1992; March et al. 1995; Markus et al. 2002; van Aken 2005; Gregor 2006; Iivari 2007; Baskerville 2008; van Aken and Romme 2009; Dresch et al. 2015; Iivari 2015; Antunes 2015) artifacts for them. Thus, DS does not search for the truth not merely tries to understand the research phenomenon, it tries to practically solve it.

In an ontological sense, the ontology of design science (Pandza and Thorpe 2010, 173; Vaishnavi and Kuechler 2015, 30-31; March et al. 1995, 256–258; Delir Haghighi et al. 2013, 1193) is multirealistic, which also includes the artificial world. Design science posits that there are many different realities, world-states, which are contextually situated and not only socially constructed, but also sociotechnologically created.

In an epistemological sense (Vaishnavi and Kuechler 2015, 30–31; Klein and Myers 1999, 2011; Robey 1996; Weber 2003; Hevner et al. 2004, 98; Lee 2000; Dresch et al. 2015, 48, 51–52, 67; van Aken 2004; Gibbons and Bunderson 2005; March and Smith 1995; Romme 2003, 558; Simon 1996), design science is "knowing by doing". Thus, according to Romme (2003, 558), the main question becomes: "Will it work?" rather than "Is it valid or true?" Design science is based on pragmatism as the underlying epistemological notion.

In a methodological sense (Nunamaker et al. 1991, 97; Dresch et al. 2015, 1–2, 16, 20,27; Hatchuel 2009; Winter 2008, 470–471; March and Smith, 1995; Rossi and Sein, 2003; Hevner et al. 2004; Peffers et al. 2006), design science does not focus on observation nor quantitative statistics. Design science does have a participative role, but instead of doing qualitative research, design science is based on making artifacts to create a new and better system. Design science develops innovative constructions, artifacts, to solve practical real-life problems. Formoso (2015, v) defined: "Design Science Research (DSR), also known as Constructive Research, is a methodological approach concerned with devising artifacts that serve human purposes. It is a form of scientific knowledge production that involves the development of innovative constructions, intended to solve problems faced in the real world, and simultaneously makes a kind of prescriptive scientific contribution. An important outcome of this type of research is an artifact that solves a domain problem, also known as solution concept, which must be assessed against criteria of value or utility."

A summary of the philosophical foundations of design science (DS) compared with positivist and interpretive research perspectives are illustrated in Table 6 (Vaishnavi and Kuecher (2015, 31, with minor modifications).

Table 6: The positivist, interpretive, and design research perspectives presented.

Research perspectives:			
Basic Belief:	**Positivist**	**Interpretive**	**Design**
Axiology	Truth: universal and beautiful; prediction	Understanding: situated and description	Control; creation; problem-solving; progress (i.e.,improvement); understanding, prescription
Ontology	A single reality. Knowable, probabilistic	Multiple realities, socially constructed	Multiple, contextually situated alternative world-states. Sociotechnologically enabled
Epistemology	Objective; dispassionate. Detached observer of truth	Subjective, i.e. values and knowledge emerge from the research-participant interaction	Knowing through making; objectively constrained construction within a context. Iterative circumscription reveals meaning
Methodology	Observation; quantitative, statistical	Participation; qualitative. Hermeneutical, dialectical	Developmental. Measure artifactual impacts on the composite system

A summary of the philosophical foundations of this dissertation is presented below. This dissertation is a means-end oriented study in an axiological sense. It does not try to interpret nor purposely make any revolutionary changes to existing situations. It does try to offer a prescriptive design (CDSS artifacts) to rationally solve the perennial process problems of psychiatric and addiction care. The epistemological base for this dissertation is to examine whether the developed CDSSs (artifacts) work to solve the perpetual process problems of health care in real life situations and in real organizations. This dissertation agrees with the ontological view of a "a single, stable underlying physical reality that constraints the multiplicity of world-states".

In this dissertation, the design science research methodology was applied to the identification of the research problem, and the reasons for conducting this dissertation have been demonstrated in the previous chapters. Briefly put, this dissertation is an effort to solve the real-life problems of previously separated, siloed, fragmented, and inefficient mental and addiction care. The literature review of design science research (Table 5) and document artifacts in the research area (a long table not included in this dissertation) broadened awareness of the current status of several development efforts for solving these issues (Tables 3 and 4) in process-based health care organizations.

Thus, in this research process, the previously mentioned research questions RQ1, RQ2, RQ3 of this dissertation emerged. In addition, this dissertation had two primary objectives: (1) to develop various CDSS-assisted critical processes for an integrated mental and addiction outpatient clinic and (2) to examine the possibilities to increase the

productivity of these critical processes in an integrated mental and addiction outpatient clinic.

The stages of the design science research process in this dissertation are presented in Figure 14.

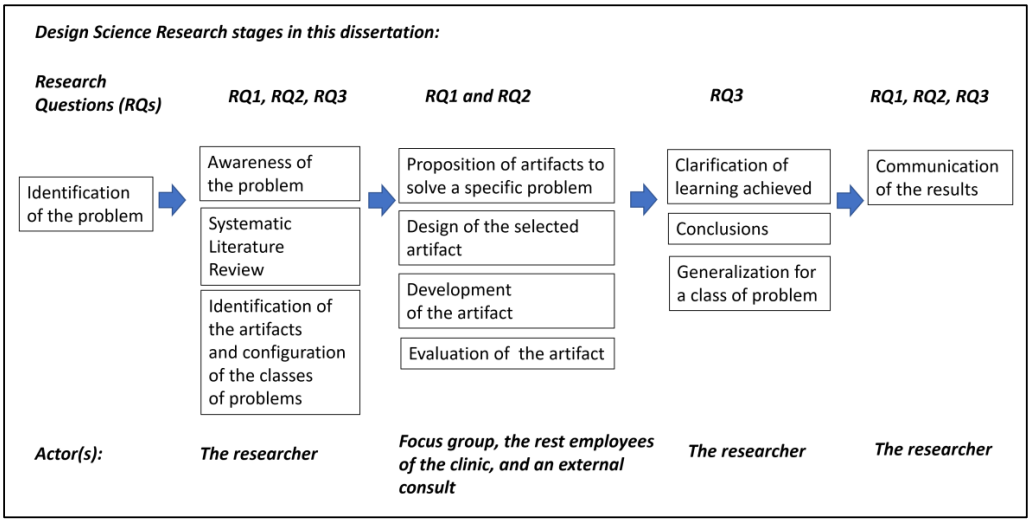

Figure 14: The applied research strategy of design science research in this dissertation (modified from Dresch et al. 2015,119).

Dresch et al. (2015, 16) outlined a general and easily understandable roadmap for design science research, "a strategy for carrying out scientific research". The real-life problems of health care have already been presented broadly. The goal of this dissertation was to create a new clinic model for integrated mental and addiction care and design an expert system, i.e. the clinical decision support systems to assist the implementation of the key processes of care. Design science and organizational development were the scientific methods used. The benefits and deficiencies of current care processes were pondered on in interviews by an external consultant and the researcher. The specifications of the core care processes were investigated. The screening tests of mental and addiction care patients were scrutinized, and the ones best suitable for the purposes of this dissertation were selected for the CDSSs. The designed CDSS was tested in real-life environments. The field test of the developed care model and the results of the process improvements are offered in the following sections. The research roadmap of this dissertation is depicted in the pendulum below (aligning with Dresch et al. 2015, 14) (Figure 15).

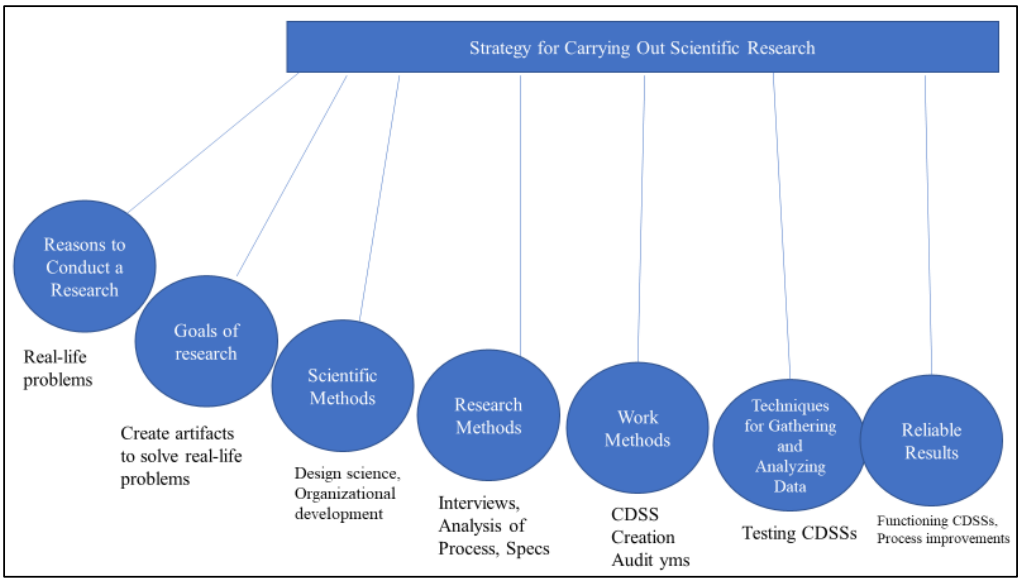

Figure 15: The pendulum for carrying design science research in this dissertation.

Concurrently with the academic research process to transform the previously siloed, fragmented, and inefficient care practices, the members of the focus group (Merton 1987; Krueger and Casey 2015; Bräuer et al. 2018) were selected to develop new processes for an integrated mental and addiction care clinic. Tremblay et al. (2010), based on Stewart et al. (2006, p. 42), give four reasons to explain why a focus group is an appropriate technique for DSR; the focus group: 1) allows direct interaction with participants, 2) provides the flexibility to deal with various design ideas, 3) offers rich and different data that allow designers to obtain a good view of the design, and 4) is a good setting to acquire new ideas/problems emerging from the participants' comments. The selection criteria for the members of the focus group included being an experienced member of their own profession (a psychiatric nurse, an addiction nurse, a social worker, an occupational therapist, a psychologist, or a psychiatrist) and having the ability to describe the care process of their profession. Some professions were excluded (for example, a nutritional therapist and a physiotherapist) in order to keep the focus group small enough, efficient, and operational. Also, patients excluded because of starting with a new team in a newly established clinic.

The author and an external consultant repeated the principles of the development of a process-based organization the first session of the focus group. Ordinary meetings and workshops were held beforehand in the clinic, where several techniques and tools of process development were discussed (for instance, how to map processes, how to depict swimlanes, and what are roles, tasks, and activities in a process map). Thus, depicting the care process of one's own profession together with the other professions (to create an entire care path of a patient in core processes) started.

Four key processes for the clinic emerged in the focus group negotiations:

1. A new process (an adult-ADHD process) of the clinic
2. A complex, multiprofessional, and the most time-consuming process of the clinic (the evaluation of work ability of mental and addiction patients)
3. The most resource-consuming process of the clinic (an opioid substitution therapy process), and
4. the most common process of the clinic (diagnosis, treatment, and rehabilitation of depressive patients).

The first three above mentioned processes were selected to develop for IT-solutions. The benefits of IT-solutions included the electric coordination of previously problematic issues. Firstly, the IT-solution offered accessible, visible up-to-date information about the state of the patient path process (who has done their share of the above mentioned key processes of the clinic). Previously it was common that one member of the team said that they had no time to do their share, which caused unnecessary delays in patient journeys. Secondly, it was quite common that each member of the team asked the same questions and used the same screening tests, which frustrated patients. The executed screening tests and their results were easily seen on the IT-solution and more detailed results were available with one touch if needed. Thirdly, the IT-solutions offered a convenient way to introduce a new employee of the team with the key processes of the clinic, which took considerably longer time to understand the entire key processes. Finally, an expert system, the clinical decision support system (CDSS), would ensure the agile, efficient, and sure implementation of the key processes of the clinic.

After the first two to four weekly sessions, the clinic-wide processes were ready to be transformed into the selected IT-solution, which was the SBM (Solution Business Manager) -platform, by an external consultant in two weeks. The next one to two weekly sessions iterated the processes in the SBM-platform, and further ideas for process development were included by the focus group and an external consultant.

The mapped and developed processes and the SBM-platform were introduced in one to two clinic meetings to the other employees of the MTPA clinic. Further suggestions were collected and improvement solutions to the SBM-platform were agreed to be executed in two weeks. The focus group and the rest of the personnel of the clinic formed a confirmatory focus group (Krueger and Casey 2015; Bräuer et al. 2018) that implemented and validated the developed processes and clinical decision support systems (CDSS) in their daily work. During daily work, problems and improvement suggestions emerged and were switfly added to the platform by an external consultant.

Table 7 summarizes the research designs of the individual publications included in this dissertation by showing the title, objective, research approach, and research methods of the publications. The design science research approach was used in publications 1–5 and the theory of constraints (TOC) and the five-focusing step (5FS) were also used in

publication 6. This dissertation is a prescriptive-driven research. All the publications aimed at model building and at developing the clinical decision support system assisted core processes in transformed mental and addiction care. The developed artifacts, the continuously iterated CDSS-models, were used to test and study the impact of the clinical decision support system in a newly established integrated mental and addiction care clinic.

The research designs of the individual publications in this dissertation are presented below (Table 7).

Table 7: A summary of research designs of individual publications in this dissertation.

	Publ. 1	**Publ. 2**	**Publ. 3**	**Publ. 4**	**Publ. 5**	**Publ. 6**
Title	A Clinical Decision Support System for Adult ADHD Diagnostics Process	Decision Support in Evaluating the Impacts of Mental Disorders on Work Ability	Clinical Decision Support System for Opioid Substitution Therapy	Redesigning Mental Health Care Service Processes to Increase Productivity	Increasing Productivity in Mental Health Care Services with an Integrated Process and Diagnostics Support System	Improving the productivity and efficiency of an integrated mental and addiction care
Objective	To develop an efficient process for adult-ADHD patients	To develop an efficient process for the work ability evaluation of psychiatric and addiction care patients	To develop an efficient process for the opioid substitution therapy of opioid dependent patients	To redesign/ reengineer the processes of traditional separated mental and addiction care	To study the effects of integrating the processes of mental and addiction care with the diagnostics support system	To study the productivity and efficiency of the application of the TOC and the 5FS to the adult-ADHD evaluation process
Research approach	Design science	Design science	Design science	Design science	Design science	Design science, TOC, 5SF
Research methods	Model building	Model building	Model building	Model building	Model building	Model building

3.2 The setting and practical background

The setting of this dissertation was the southeast of Finland, the South Karelia District of Social and Health Services (Eksote). It was one of the first national pilots to integrate

public services – primary and secondary health care and social care. The day care of children, environmental health, and veterinary service were excluded. In the beginning, eight (Imatra joined in later as the ninth member in 2016) municipalities participated in Eksote. The new social and health care organization (called the South Karelia District of Social and Health Services, 1.1.2009) was a reaction to the increasing costs of social and health care. The escalating costs of social and health care required the redesign of the entire social and health care system. The strategic aims of the South Karelia District of Social and Health Services were: the needs of customers and patients to guide service production, the renewal of service production and supply chains, the creation of a working culture with shared values, and the continuous improvement of productivity and economics (Klemola 2015, 106).

Eksote delivers patient-oriented care to the approximately 130 000 citizens of South Karelia. In 2018, it employed approximately 4 880 people and had a budget of 515 million euros. The services operate in a geographical area of over 5 600 square kilometres, 100 kilometres in width and 200 kilometres in length. According to the strategic aims of the South Karelia District of Social and Health Services, mental and addiction care service processes were redesigned/re-engineered as well to gain instant results in 2010–2015. The redesigning of integrated mental and addiction care was implemented in three steps. Firstly, a new organization model was established. Secondly, the processes were redesigned/re- engineered. Thirdly, an extensive decision support system was created to implement and sustain the key processes as efficiently as possible.

The MTPA model and its local modifications have been tried in three different working places and multiple settings (Lappeenranta 2011–2015, Kotka 2016, and Vaasa 2018–2019). These were experiments conducted in real-life situations in ordinary workplaces, which pursued and still pursuit to deliver value for patients in new standardized key processes.

The reasons for establishing a new organization model and, at the same time, conducting a study at the end of 2010 were apparent. Redesigning/reengineering past mental and addiction care services was needed. The business process redesign (BPR), also known as reengineering or process innovation (Stoddard and Järvenpää 1995), enabled organizational transformation, profound fundamental changes in thought and actions.

In addition to the mentioned general cost incentives, we had several problems in supplying mental and addiction care. We had, for example, waiting times of five to seven weeks (waiting lists, queues) for the first appointment for a new patient in psychiatric outpatient care. Furthermore, referrals were needed from general practitioners, occupational physicians, or private physicians, which meant about two additional weeks of waiting for the customers/patients. The open ward and inpatient department still worked in fragmented and isolated ways, which originated from the previous functional service design. With the general situation in psychiatric and addiction care so inefficient, there were unusual local arrangements to guarantee the social security (briefly, the livelihood) of the patients. The local general practitioners could, because of the lack of

psychiatrists in outpatient care, write more extended certificates of sick leaves (B-certificates, a document of over three pages) to protect the necessary allowances for all-day living. The primary function of the open ward psychiatrists was to write several arduous B-certificates (four to six) per day, which did not tempt psychiatrists to work in an open psychiatric ward.

Also, as mentioned, long waiting lists existed, which caused the patient flow of the open ward to not work within daily office hours. It resulted, yearly, in worsening the "overflow" of psychiatric patients into the somatic emergency care and psychiatric inpatient care, as illustrated in the following Figure 16. Thus, in 2009, 72 percent of psychiatric patients arrived in care outside daily working hours from 4 pm to 8 am.

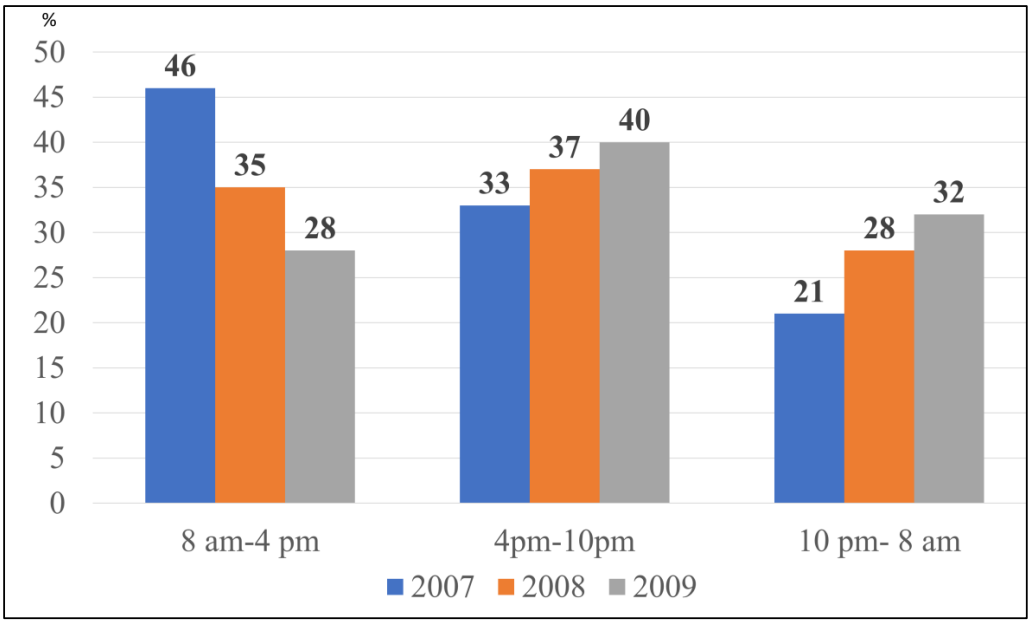

Figure 16: The percentage of daily flow of psychiatric patients in 2007–2009.

Access to care was one of the reasons which increased dissatisfaction among patients and their relatives, employees of open wards and inpatient departments, and employees of somatic emergency care. At the same time, with the continuous cost-cutting challenges, it was evident that there would not be extra outside resources for developing mental and addiction care. The resources, if any, must be taken from the current resources and budgets of mental and addiction care. Thus, the current service systems of mental and addiction care must be scrutinized for reallocating resources. Psychiatric inpatient care had four inpatient departments, where the utilization rate was close to 100 percent and sometimes even over 100 percent. The overflow of inpatient treatment was evident after the abovementioned problems in delivering outpatient care. As a solution to the problems above, two psychiatric inpatient departments were closed down to liberate resources for

developing open ward mental and addiction care, as had been the intent in the 1990s. For decades, governmental agencies have proclaimed demands to allocate more resources for developing open wards. Deinstitutionalization was a common trend, which started in the 1990s in psychiatry. As mentioned, the deinstitutionalization of psychiatric hospitals proceeded fast. The main reason was the economic depression in the 1990s, not the development of outpatient care nor the failure to allocate resources for developing outpatient care. The deinstitutionalization in South Karelia in 2008–2018 is described in Figure 17 below, which also includes child and adolescent psychiatric hospital beds.

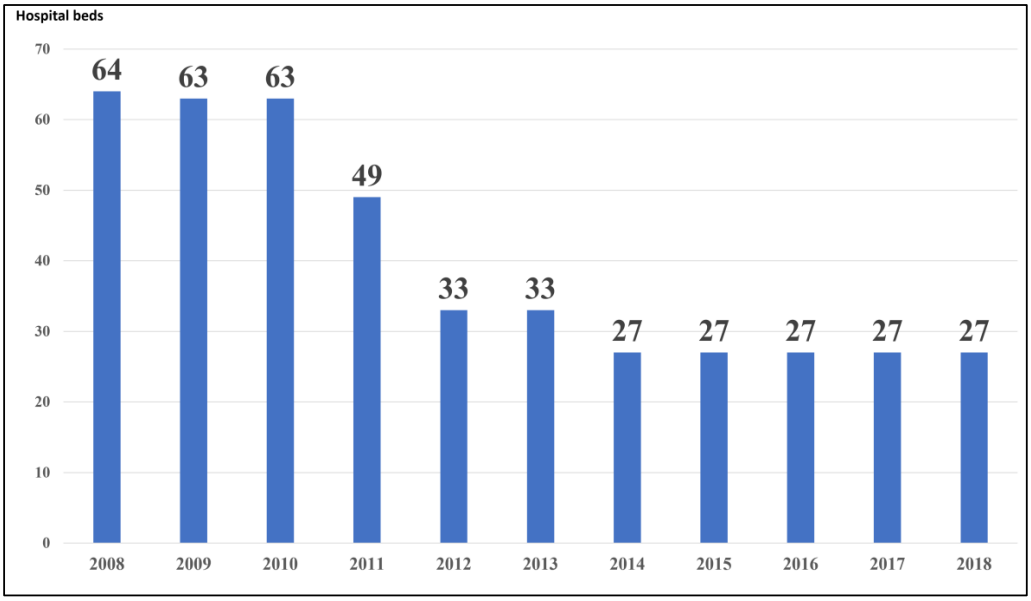

Figure 17: The development of adult psychiatric beds in 2008–2018 – In 2010, Ps1 and Ps3 - Ps2 had 17 beds and 15 beds in 2011, Ps2 closed down in 2012.

Firstly, the resources liberated from those two closed inpatient departments provided assets to develop a new open and integrated mental and addiction ward. According to the new integrated model, in each of the municipalities of South Karelia belonging to the South Karelia District of Social and Health Services, one or two vacancies of psychiatric nurse were established in their primary care health centres. The nurses delivered integrated care for both psychiatric and addiction patients in these local places, together with the employees of local health centres. In the biggest municipality, Lappeenranta, psychiatric nurses were allocated to three different primary care health centres (Armila, Lauritsala, and Sammonlahti). Besides these, a new walk-in clinic (the MTPA model) was established in the central hospital of South Karelia. The central hospital also is also located in Lappeenranta. The established MTPA model did not have any previous examples in Finland.

Secondly, a new way of thinking about psychiatric and addiction care was developed – the process thinking approach (Levett and Burney 2014). The traditional way of organizing an outpatient clinic is illustrated in Figure 18 below. This traditional way of organizing care has frequently led to other things: long waiting lists, inefficient handoffs, long lead times, and siloed functioning, which led to the organizational focus (Figure 3 left side) of the organizational culture. The business process management approach educated to the focus group (Krueger and Casey 2015), which led to paradigmatic changes in the organizational culture. One of the groundbreaking changes was to reject traditional referrals. Referrals were identified as bottlenecks in delivering efficient integrated mental and addiction care. The walk-in principle (open 24/7/365), a non-referral way, was selected to alleviate and solve the problems of accessibility of care. In fact, the removal of referrals solved, a wicked process problem (the waiting lists), the accessibility problem at once.

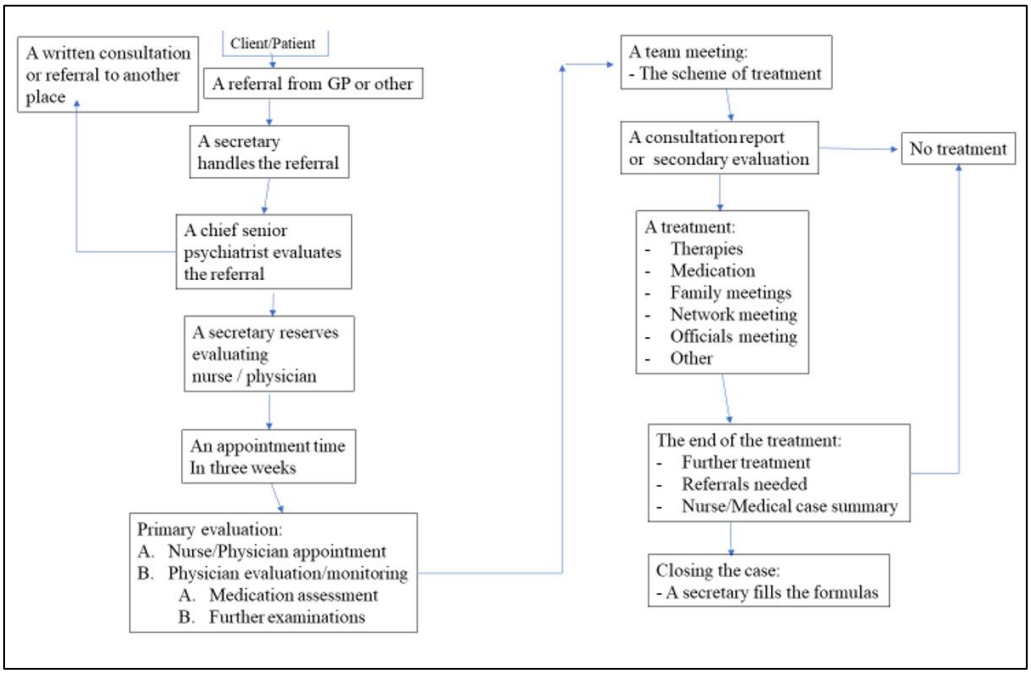

Figure 18: The traditional path of psychiatric consultation.

A new focus group designed a way of working in integrated mental and addiction care (MTPA), which is presented below (Figure 19). Two familiar slogans guided the design of care in the focus groups. The two questions visualized a new way of conceptualizing care: 1) How would you like to be served as a patient yourself? and 2) Would you bring your loved ones to receive treatment in our clinic? Two affirmative answers to these questions formed a solid ground for the new effective clinic. Also, the goal was to have no waiting time at all or minimum waiting times and more client/patient-centred

behaviour at the beginning of the treatment path. Traditionally, the path of the patient had been organized according to the preferences of the employees, not the illness or the suffering of patients. It was negotiated between the employees of MTPA that if any patients are waiting in a corridor, the processes do not work in the best possible way. A well-known fact is that there is 30–80 percent waste in health care processes (Harrington 1983; George 2003).

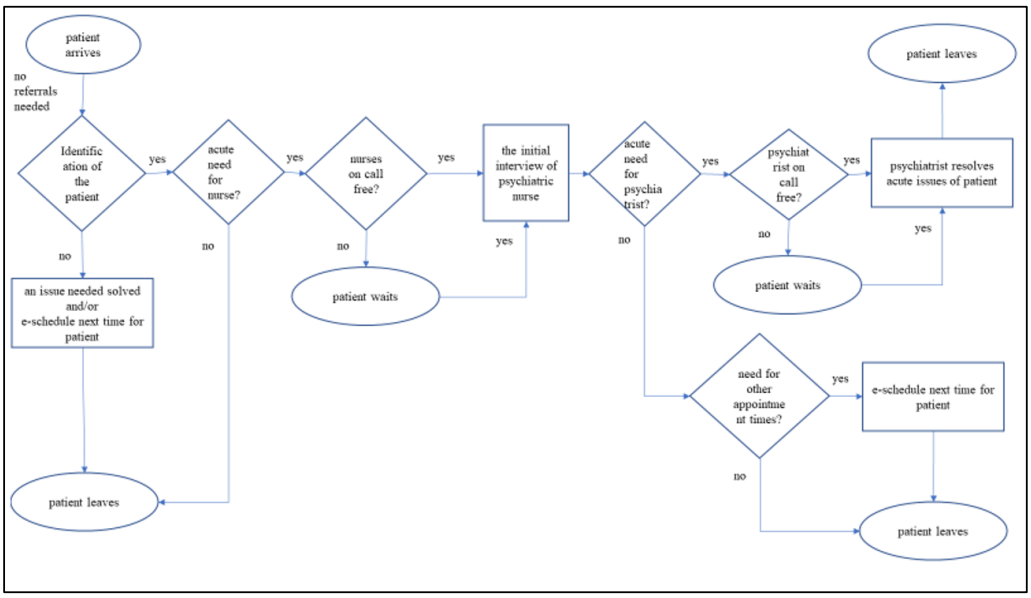

Figure 19: The workflow of MTPA.

Initially, the integrated mental and addiction care clinic, MTPA, was designed for a process-managed organization (Repa 2011). The processes of MTPA were designed and mapped according to a business process management (Mahal 2010) model. The illustration of the processes was initially depicted in the SIPOC-format (Munro et al. 2008, 50–53). The key processes were the new adult-ADHD process, the complicated work-ability evaluation process, and the opioid substitution treatment process demanding resources. Repa (2011, 624) depicted the idea of process management and defined the key processes and supporting processes: “Key processes are the processes in the organization, which are linked directly to the customer. They cover the whole business cycle from an expression of the customer’s need to its satisfaction with the product/service. The supporting processes are linked to the customer indirectly, and they support particular products/services. The key processes play the crucial role. Mutually interconnected critical processes of the whole system are tied together with the customers’ needs. The supporting processes are organized around the key ones: the internal behavior, specialization, and even the effectiveness of the organizations’ activities are subordinated

to the customers and their needs." Similarly, Laamanen (2003) advocated process thinking similarly to a business managing strategy.

The principles introduced in the Toyota Production System (Womack and Jones 2003) and Lean thinking (Modig and Åhlström 2016) also applied to the organization of MTPA. Furthermore, the Six Sigma thinking tried to monitor the progress of the implementation of the new MTPA model. Statistical process control (SPC) (Oakland 2011) was tried preliminary, and it was possible to apply to a certain degree. However, problems of disintegrated and inaccurate data and its inhibited use abolished the full use of the SPC. The fear of what the data would unveil efficiently probably prevented the use of the data. One main reason for the disintegrated data was the initial coding process. Employees entered the patient information to the EMS (electronic medical system) incomplete and unmonitored. Legal regulations for forming registers in the organization had not been established. The use of available data and statistics was also unestablished. Interest in up-to-date data in the organization was minimal.

Finally, the previous knowledge base of national and regional mental health projects consisted of observations such as "these projects have remained relatively short and limited, which has made achieving real change in outcomes related to mental health more difficult" (Patana 2014, 29). Therefore, to guarantee the successful establishment and implementation of the MTPA model, various clinical decision support systems (Berner, 2009) were created and implemented. As Berner (2009, 4) delineated on clinical decision support systems: "Clinical decision support systems provide clinicians, staff, patients, and other individuals with knowledge and person-specific information, intelligently filtered and presented at appropriate times, to enhance health and healthcare."

Several focus group sessions and meetings (Krueger and Casey 2015) were held, where the preliminary characteristics and their iterations of the key processes were made. Krueger and Casey (2015, location 572/5972) described the five characteristics of the focus groups: 1) a small group of people, usually five to eight people, 2) who possess specific characteristics, 3) they provide qualitative data, 4) they are involved in a focused discussion, and 5) they help understand the topic of interest. Tadajewski (2016,319) defined focus groups, according to Morgan (1996), "as a research technique that collects data through group interaction on a topic determined by the researcher". Krueger and Casey (2015, 478/5972) warned about the role of the researcher being too directive and the role of the focus group members being too passive, which might conceal information in an unsafe situation and lead away from the focused issue. Alturki et al. (2011, 6-7) cited Steward et al. (2006) and Tremblay et al. (2010) on why a focus group is an appropriate technique for DSR. Firstly, it provides direct interaction with participants. Secondly, it provides the flexibility to deal with various design ideas. Thirdly, it offers rich and different data that allow designers to obtain a good view of the design. Fourthly, it is an excellent setting to acquire new ideas/problems that emerge from the participants' comments. The method of the focus group was successful in disclosing the characteristics of the key processes.

The selected members of the focus group had the motivation and group skills to articulate their professional domain and work efficiently. The members represented each employee group (a psychiatrist, an addiction physician, a chief nurse, a psychiatric nurse, an addiction nurse, a neuropsychiatric nurse, a psychologist, a social worker, and, moreover, an IT software developer specialist, who was an external consult). The different key processes (adult ADHD, workability evaluation of psychiatric and addiction patients, and opioid substitution therapy assessment and treatment) and the roles, tasks, and activities of each profession in these processes were outlined. Furthermore, the selection of screening tests of each critical process was made, various questionnaires and background information forms for each key process were developed, and each employee group participated in the focus group sessions and in individual profession-specific sessions. The procedure assured that each profession could execute their best practice and abolished common fears about physicians' dominance in the entire process development. The common symptoms of adult ADHD are presented in Figure 20.

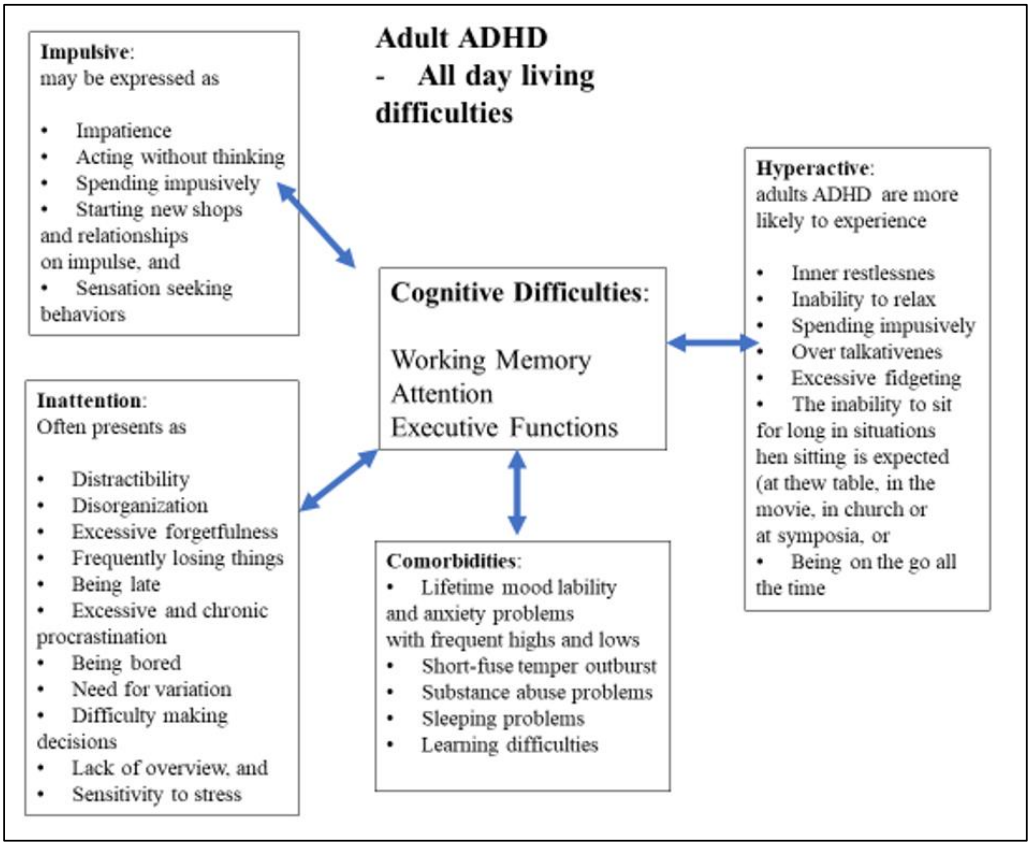

Figure 20: The main symptomology of adult ADHD consists of impulsive, inattention, and hyperactive symptoms.

These adult ADHD symptoms were discussed in the focus groups and transformed into different roles, tasks, and activities of the team. The extensive work-up of different professionals in the adult ADHD process are presented in Table 8.

Table 8: The extensive work-up of professionals in the adult ADHD process.

Team	**Tools / tasks**
Social worker	- Designed functioning level questionnaire of social situation, based on interview - SOFAS (Social and Occupational Functioning Assessment Scale) assessing social, occupational and relationship functioning in the last year (current, past and best in ongoing year); is an overall functioning scale - AUDIT (Alcohol Use Disorders Identification Test), describes how to use it to identify persons with hazardous and harmful patterns of alcohol consumption. The AUDIT was developed by the World Health Organization (WHO) as a simple method of screening for excessive drinking and to assist in brief assessment. It can help in identifying excessive drinking as the cause of the presenting illness. It also provides a framework for intervention to help hazardous and harmful drinkers reduce or cease alcohol consumption and thereby avoid the harmful consequences of their drinking.
ADHD-nurse	- ASRS v1.1 (A- and B-parts), WHO Adult ADHD Self-Report Scale (ASRS) Symptom Checklist. The A-part is a self- report questionnaire, the B-part is an evaluation part, which the ADHD nurse fills out - DIVA (Diagnostic Interview for ADHD in adults) 2.0 Summary A and H/I about symptoms, based on interviews of the relatives of adult ADHD patients - interviews concerning childhood and adulthood, teacher interview, lifestyle interview
Psychologist	- DIVA (Diagnostic Interview for ADHD in adults) 2.0 Summary A and H/I about symptoms, based on interviews of adult ADHD patients - WAIS-III (Wechsler Adult Intelligence Scale - III) for the assessment of current intellectual functioning - WMS-III (Wechler Memory Scale -III) for assessment of overall memory skills - a wide range of standardised neuropsychological test batteries for assessing specific cognitive strengths and weaknesses: language, speech and communication skills, attention, concentration and executive functioning, reading and writing skills
Addiction nurse	- Urine specimen, screening for drugs - SDS (The Severity of Dependence Scale); provides a short, easily administered scale which can be used to measure the degree of dependence experienced by users of different types of drugs. The SDS contains five items, all of which are explicitly concerned with psychological components of dependence. These items are specifically concerned with impaired control over drug taking and with preoccupation and anxieties about drug use - EuropASI (European Addiction Severity Index), only the part about screening drugs - the nurse's part of PRISM (Psychiatric Research Interview for Substance and Mental Disorders): the PRISM is a semi- structured clinician-administered interview that measures DSM-III, DSM-III-R, and DSM-IV diagnoses (current and past) of alcohol, drug, and

	psychiatric disorders and continuous measures of severity, organic, etiology, treatment, and functional impairment
Occupational therapist	- AMPS is comprised of 16 ADL motor skills items and 20 ADL process skills items the occupational therapist scores across two ADL tasks (72 items in total). As a result, the AMPS is a highly sensitive measure of ADL performance - MOHOST (The Model of Human Occupational Screening Tool), addresses the client's motivation for occupation, pattern of occupation, communication, process and motor skills and environment - OSA (Occupational Self Assessment), is designed to capture the client's perception of their own occupational competence on their occupational adaptation - Home Assessment, the role of assessing the home environment from the person's perspective is critical to the person's daily routines and self esteem
Psychiatrist	- BPRS (The Brief Psychiatric Rating Scale) is a rating scale which a clinician or researcher may use to measure psychiatric symptoms such as depression, anxiety, hallucinations and unusual behaviour. Each symptom is rated on a scale of 1 to 7, and depending on the version between a total of 18–24 symptoms are scored - MADRS (The Montgomery–Åsberg Depression Rating Scale) is a ten-item diagnostic questionnaire which psychiatrists use to measure the severity of depressive episodes in patients with mood disorders. - MDQ (The Mood Disorder Questionnaire), screening instrument for the bipolar spectrum disorder, developed by Robert Hirschfeld - YMRS (Young Mania Rating Scale); a rating scale used to evaluate manic symptoms at baseline and over time in individuals with mania. The scale has 11 items and is based on the patient's subjective report of his or her clinical condition over the previous 48 hours. - PROD-screening; for prodromal symptoms of psychosis, PROD-screen consists of 29 questions assessing performance and symptoms - Applied and lengthened broadened SCID (Structured Clinical Interview for DSM-IV Axis I Disorders); to facilitate writing psychiatric reports for various purposes (for example to social security authorities, police, courtroom and employment authorities)

The different roles, tasks, and activities and when they have been executed are presented in the first CDSS layout (the adult ADHD process), see Figure 21.

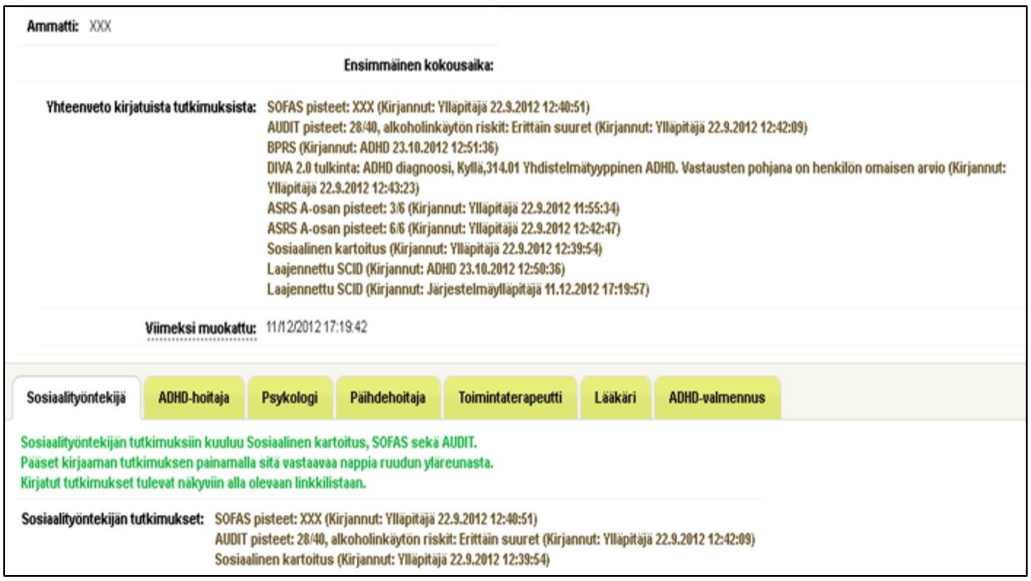

Figure 21: The display of the first CDSS (the adult ADHD process) presents the different roles, different screening tests, and the times when these were executed.

The whole adult ADHD process was transformed in the focus group interviews and discussion into a technical process depiction of the tailor-made CDSS software presented in Figure 22.

The motivation for the use of CDSS was created based on several ideas from the business process and operational research literature. Hammer and Champy (2006, 5) stated: “From its inception, re-engineering has been a close partner of information technology. Technology enables the processes that are the essence of re-engineering to be redesigned. The two have a symbiotic relationship: Without re-engineering, information technology delivers little payoff; without information technology, little engineering can be done. The most important reengineering-related technology of the last five years has been enterprise resource planning (ERP), an integrated software system that supports not individual functional areas but complete business processes. Companies that have attempted to implement an ERP system without first (or simultaneously) re-engineering their processes were disappointed by modest payoffs they received (outside the narrow domain of improved information technology operations and cost).” Völkner and Werners (2000, 633) outlined: “A process-orientated organization aligns the workflows to the benefits for the customers. Typical problems of structure-referred organizations result from a lack of coordination in the case of separated responsibilities for dependent functions; these are to be avoided by a process- oriented organization.”

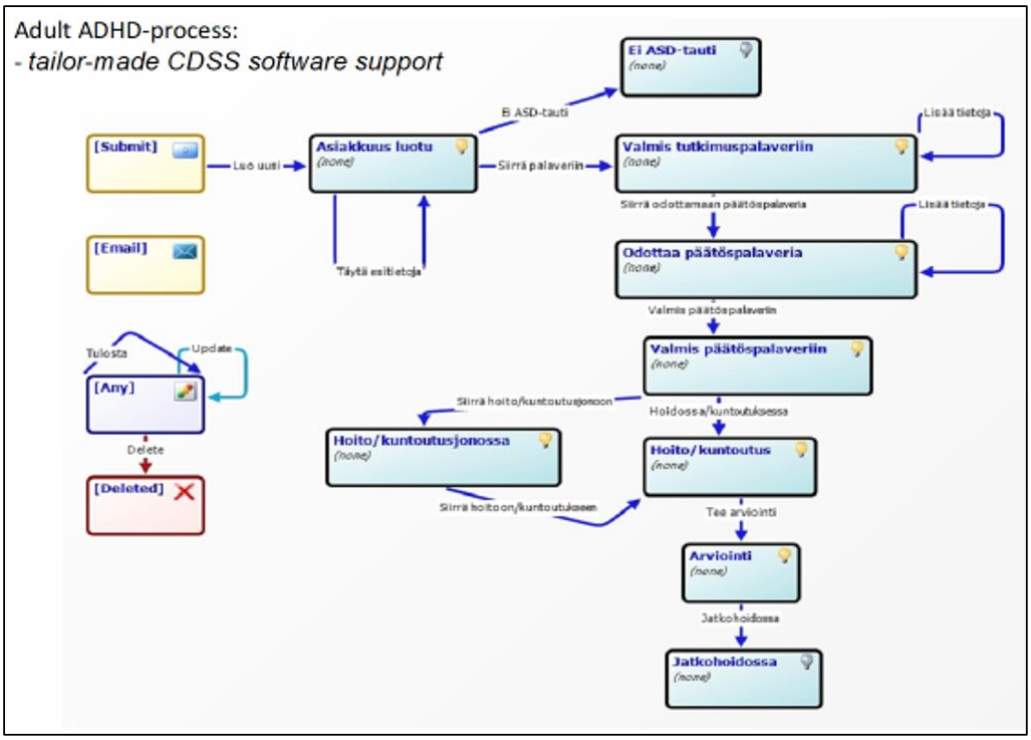

Figure 22: The tailor-made CDSS software support of the adult ADHD process.

D'Andreamatteo et al. (2015, 1198) cited Kim (2006) in that organizations adopting Lean principles and techniques can overcome cultural and practical barriers: "Among these barriers is the suspicion against management tools imported from a context other than healthcare, a misunderstanding of what Lean aims to achieve by cuts and layoffs, and the difficulty to act as a whole by units that are accustomed to functioning as autonomous "silos"." Frank Cohen (2010, x) wrote: "Improving profitability by improving processes is not just a concept; it is a mandate for medical providers and their staff. Even more than that, it is a moral imperative."

Thus, re-engineering/redesigning the health care process with the clinical decision support system offered an efficient method to accomplish the required changes in the new integrated mental and addiction care clinic. Furthermore, literature on successful organizational changes pointed out two critical features of successful organizational reorganization. The use of CDSS could be efficiently guaranteed by the proper implementation and lasting sustainability of the developed processes. The CDSS also contributed to the overall design, development, and establishment of the key processes. The Serena platform for the CDSSs was already available in the organization to process management efforts. The efforts of figuring out the critical processes of MTPA and, at the same time, the specific roles, tasks, and activities of individual employees produced

an easy-to-implement model for process management. The South Karelia District of Social and Health Services also had a tool (the IMS) for developing processes. The IMS (integrated management system) was rejected because it was too static and not agile enough. The IMS provides excellent tools to map out the processes and describes accurately the processes, but there was a risk that they would be "shelved" after the mapping. The Serena platform offered an agile and easy to iterate vehicle to better processes. The employees worried that the fundamental processes would be too physician-centred, and other employees would be in subordinate positions. In the Serena platform, every employee group can design the very best practice for their domain.

The purpose was to develop an interface layout, where a general view of the whole process can be seen on one page. Furthermore, in the layout, the current care path of an individual client/patient can be quickly followed and monitored.

The further development of CDSSs makes it possible for an ERP-system to facilitate several critical tasks and aims of the newly established walk-in clinic, the MTPA clinic. The designed and implemented CDSSs and the successive ERP created value:

1. as a platform which collects individual patient group processes together and adds an organization and personal resource views
2. as a transparent management device for the entire organization by describing a full view of patients and their resources
3. as a vehicle to set targets, objectives, and specifications for the selected team and personal measurements
4. as an instant alert system for problems, deviations, and outliers of standard procedures
5. as a guide for employees to understand the big picture of the enterprise and to implement the new working model of the organization
6. as a quick summary of services and employees involved in the care of the patient to plan appropriate procedures of care
7. as a recovery plan where the views of patients and their relatives and the employees are brought together to design a treatment plan.

4 Review of the results

This chapter includes the main results of this research. First, the research questions are answered and the individual publications in this dissertation are summarized according to the research questions. The objectives are (1) to develop various CDSS-assisted critical processes for an integrated mental and addiction outpatient clinic and (2) to examine the possibilities to increase the productivity of these critical processes in an integrated mental and addiction outpatient clinic. Second, the results are reviewed through the objectives of this dissertation.

4.1 Research questions answered and summary of publications

In this dissertation, six different papers focus on designing, developing, and establishing a new integrated mental and addiction care clinic (the MTPA model). The two primary objectives of the dissertation are 1) to develop CDSS-assisted key processes to the MTPA model and 2) to examine the possibilities to increase the productivity of these key processes of the MTPA model. The first objective has been divided into two research questions: (RQ1): "What are the key process characteristics in newly established integrated mental and addiction care (MTPA)?" Moreover, (RQ2): "How is it possible to support process development by redesigning or re-engineering business processes with clinical decision support systems in new integrated mental and addiction care (the MTPA model)?" Research question 1 was addressed in publications 1, 2 and 3.

The process development level is at the clinical processes level (L3-L4 level, Figure 23), and the swimlanes and the work instructions are the target data. Research question 2 was addressed in publications 4 and 5. The redesigning/reengineering of the traditionally separated mental and addiction care was answered at the clinical processes level (L2 level).

The other objective of this dissertation was to examine the possibilities to increase the productivity of these key processes of the MTPA model. The third research question (RQ3) "How is it possible to improve the productivity of each new critical process in new integrated mental and addiction care (the MTPA model)?" is addressed in publication 6. The theory of constraints (TOC) and the five-focusing step (5FS) of the TOC were introduced into integrated mental and addiction care.

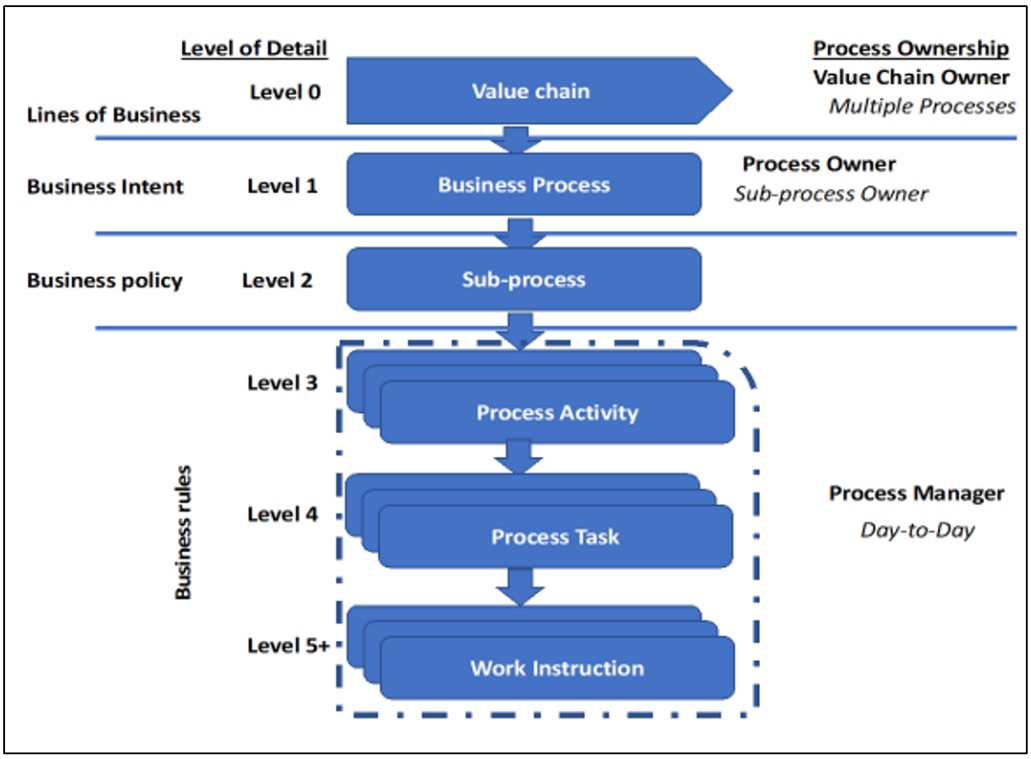

Figure 23: Process Hierarchy Guide (Mahal 2010, 39).

The primary objectives of the first three publications were to design, develop and implement an efficient process in the critical key processes of the newly established integrated mental and addiction care clinic, the MTPA model. The first process to be designed was a new adult-ADHD evaluation and treatment process. Never before have these adult-ADHD patients been evaluated, diagnosed, nor treated in a research setting in the South Karelia District of Social and Health Services. The second process to be designed was a very complicated workability evaluation process of psychiatric and addiction patients. Before, the workability evaluation process had had many inefficient handoffs, and it was a slow and long process for everyone when the patients waited for their next meeting with the next professional. In the beginning, the entire evaluation process could last over a year. The third key process was an opioid substitution therapy process, which was the most resource demanding process. The opioid substitution assessment patients, i.e. patients dependent of opioids and other addictive substances, form a very demanding patient group with easily changing requirements which often require quick solutions.

Previously, there were no key processes mapped nor depicted. The first three CDSS-assisted development processes enabled the general form of the diagnostics process

workflow in all these key processes in MTPA which are illustrated in Figure 24, as a "thinned" key patient process (Repa 2011, 629), where supporting processes and subprocesses have been eliminated.

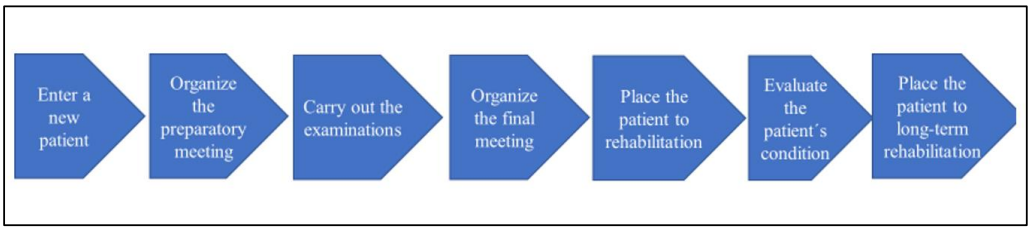

Figure 24: A general form of the entire patient path of the key process of MTPA.

The first three CDSS-assisted processes were augmented to form an efficient and universal practice and workflow for a new clinic to diagnose these and other distinct diagnostic patient groups efficiently. At the same time, the tasks, roles, activities, and responsibilities of each profession became clearly defined and understood.

These three Serena-platform designed key processes in the newly established MTPA model allowed each person in the clinic to easily perceive the entire standardized diagnostic process of each patient group. The progress of the patient in these processes is easy to monitor with one glance of the CDSS. Similarly, common inquiries of the phases and the patient's exact location in the process from the patient, their relatives and different employees from within and outside the organization could be answered quickly after just one look at the CDSS in question. The general uncertainty involving patients vanished at once with these CDSSs. Also, WIP (work-in-process, George 2003) made the most typical problem of health care processes easily visible and open to scrutinizing. Many disappointments regarding all kinds of inquiries and dubiety about patient-specific processes and what exactly is happening in the clinic were resolved as a result of better service and the possibility for better service satisfaction.

The first three CDSS design, development, and implementation projects had phases similar to agile business process development. The project team worked in focus groups, which consisted of different professionals. These professionals were involved in the evaluation, diagnosis, and treatment of the distinct patient groups (adult ADHD, working ability evaluation of mental and addiction care patients, and opioid substitution evaluation). One external consultant (an engineering degree granted by a polytechnic and specialized in computerizing processes) was included in the project team to facilitate the CDSS development. The four phases of the development projects were: 1) process definition, 2) solution development, 3) user acceptance testing and training, and 4) user training and implementation. In the first process definition phase, the definition, scope, and specifications of the process in question were determined in focus group discussions and in separate discussions with different professionals by an external consultant. The

definition phase lasted about two weeks. In the second solution development phase, the external consultant offered an initial computerized version of the process in question within one or two weeks. The project team had frequent meetings where several quick iterations of the proposed solution were made. The external consultant made new versions at two week intervals between the meetings. The iterative approach enabled the project team to steer, control, and see instant and required changes in the CDSS solution. The third phase, user acceptance testing and training, was begun after a satisfying solution had been designed. In this phase, the designed CDSS solution was initially tested among broader users in order to spot potential errors and bugs. This third phase lasted about a month and usually several changes were made to workflows, diagnostic tools, and some features of the CDSS in the Serena platform. The final and fourth phase consisted of user training and final implementation of the CDSS solution. This kind of an iterative development approach abolishes almost every possible functionality problem in the implementation and commissioning of the CDSS solution of these three processes. The three CDSS solutions (adult ADHD, working ability evaluation of mental and addiction care patients, and opioid substitution evaluation) combined a process workflow management system with the decision support system.

The experiences from these three designed CDSS solutions from the year 2012 have been mainly positive. The process-based organization concept and process workflow management system have enabled and improved the efficiency and productivity of the entire MTPA model. All employees had clearly defined task lists with due dates and status notifications. The total transparency of these key processes was augmented to only include the necessary meetings when all the employees had executed their tasks. Before the CDSS solutions, it was usual that one or more employees announced that they had not met a patient yet, which caused rework and new meetings with the same patient. The multiprofessional meetings became more active and adequately prepared when only completed cases were dealt with. A lot of expensive multiprofessional team meeting time was saved from rework and inefficiencies.

The standardized CDSS-assisted processes guaranteed that the evidence-based practice and similar selected tools (for example, screening tools and tests) were used in the key processes. At the same time, these CDSS and map-streamed processes offered an efficient way to familiarize new employees with these processes. The turnover of physicians is a common feature in current health care. Usually, a new physician in the team changes the entire work process flow and practice in the clinic within the existing multiprofessional team. Other professionals adopt the peculiar habits of the new physician, which makes it impossible to systematically develop processes in the long run. The same notion also applies to the other newcomers of the multiprofessional team.

The agile development process enabled quick and necessary changes at minimal costs. Commercial software are fixed and not easily configured to individual workplaces. Commercial software do not usually have opportunities to finetune the software. On the Serena platform, the iterative changes to processes could be made easily and quickly. This empowered the employees to suggest and develop the processes of the clinic. Several

useful suggestions were made by the MTPA personnel to develop the processes for mental and addiction care in 2011–2015. The opioid substitution treatment (OST) CDSS was the first CDSS which was a joint effort with both open and inpatient service systems.

The creation of a comprehensive CDSS architecture became obvious when developing these three CDSS solutions. The overall CDSS architecture should include all the screening and diagnostic tools in use, combine all individual process solutions in mental and addiction disorders, and enable the planning and management of each care path phase (prevention, assessing, diagnosing, treating, and monitoring) of each patient. Saunders and Vehviläinen-Julkunen (2016) and Gaudiano and Miller (2013) pointed out the difficulties in implementing best practice and evidence-based procedures in health and psychiatric care. The overall CDSS architecture would guarantee what Saunders and Vehviläinen-Julkunen (2016, 129) called for: the "integration of best evidence into clinical care delivery is essential for improving quality of care and patient outcomes".

Similarly, mental and addiction care patients usually have several disorders (aka comorbidities) and different services simultaneously. This big picture accentuates the importance of having an instant overall view of each patient and their disorders. The unnecessary repetition of tests is avoided when the specific screening and other tests and diagnostic tools are recorded in the platform. Moreover, information about interventions for the patient eliminated the double work of employees and the annoyance of the patient to disclose the same information over and over again. The whole service path of the patient could be seen at a glance. The platform helped in easily following the service path of the patient.

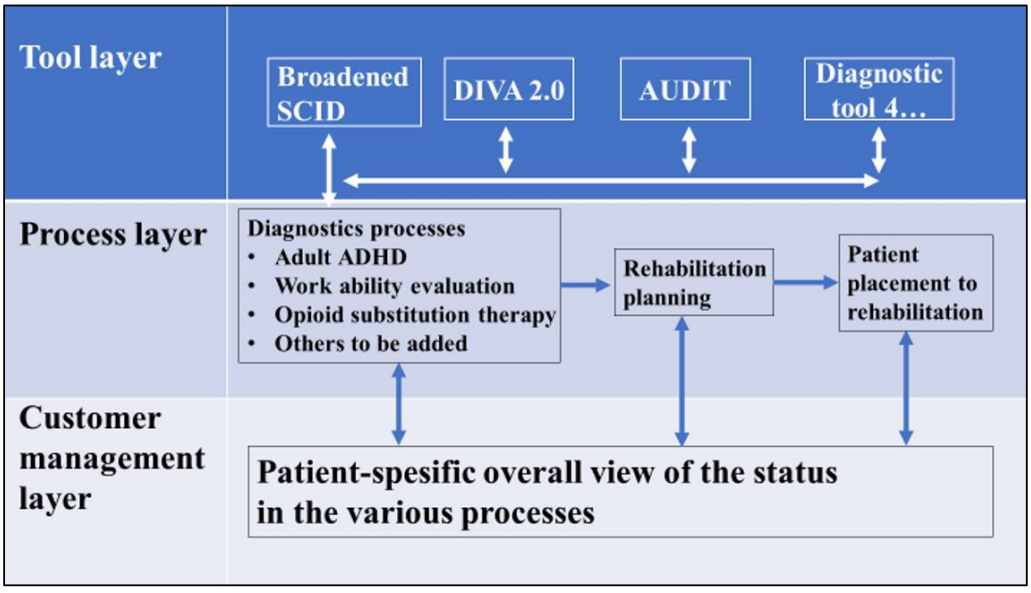

Figure 25: The architecture of the mental health and addiction care CDSS.

The overall CDSS architecture (figure 25) had a screening and diagnostic tool level, including all screening and diagnostic tools in use. The screening and diagnostic tools were not disorder-specific but could be used in several disorders. The screening and diagnostic tools as an individual module assisted the effective use of the tool in question. The diagnostic process layer could consist of all the mental and addiction disorder processes in the future. The diagnostic process level assisted in managing the process workflows and combining the right set of screening and diagnostic tools used in each patient. The patient or customer management layer highlighted and enabled overall coordination across different processes and domains. A patient's name or social security number in the CDSS could open an instant summary of the patient or customer management layer. That layer covered all the screening and diagnostic tools applied, the diagnostic processes involved, and the care path plans defined and executed to the patient or customer in question. The patient or customer management layer abolished a few of the common complaints of the patients – the need to tell the same stories again and be exposed to the same tests and tools continuously. The person-centric relevant information was available at a glance. That information, laws and permissions permitting, were quickly shared with different organizational domains (in the future in the broader ecosystem) in order to avoid unnecessary repetition on behalf of the patient and unnecessary rework in different organizations. The three-layer architecture of the CDSS provided a platform where new screening and diagnostic tools and diagnostic processes can be added flexibly.

Finally, besides the CDSS, other artifacts were also designed; these were the eHealth and mobile applications considered to diminish the need for service-desk, face-to-face contact, and at the same time to increase electronic transactions. HYVIS was a general questionnaire about mental and addiction symptoms located on the Internet. HYVIS had "traffic lights" according to the answers (for instance red = psychotic symtoms). If the person provided alarming answers, an alert was sent to the process owner nurse who contacted the person immediately. The HYVIS, a designed psychiatric on-line questionnaire, a form of an eHealth-service, has easily same information as two to three visits to taking history from a patient by a psychiatric nurse.

To summarize, the three developed CDSS solutions (adult ADHD, working ability evaluation of mental and addiction care patients, and opioid substitution evaluation) included comprehensive reporting possibilities. Unfortunately, the developed CDSSs in the Serena platform did not enable a two-way connection with the electronic health record (EHR) in use in the South Karelia District of Social and Health Services. The double booking in both the developed CDSS and the official EHR made it impossible to take advantage of the reporting possibilities. Regrettably, when the negotiations with the EHR vendor did not succeed in solving this vendor-lock-in syndrome in the booking, the full use of the developed CDSS was finally stopped. Also, the support from top management faded towards the year 2015. It was impossible, useless, and unethical to practice double booking in the busy work of the MTPA personnel. What is even more unlucky, the needed

two-way connection solution between the EHR and the developed CDSSs would have taken a few hours of work from a qualified engineer technician. However, it did not get implemented in the five years of the MTPA model. The reporting possibilities included calculating the lead time, identifying the bottlenecks of the processes, and profession-specific measurements of the individual phases of these workflows. The developed measurement results should have allowed further development of the key and other processes in MTPA. Table 9 summarizes the publications in this dissertation.

Table 9: A summary of the publications in this dissertation.

	Publications	Objective	Main results	Main contributions
P1	A Clinical Decision Support System for Adult-ADHD Diagnostics Process	To develop an efficient CDSS-assisted key process for adult-ADHD-patients	A CDSS-assisted adult-ADHD patient process	A new entire patient journey for an adult-ADHD patient
P2	Decision Support in Evaluating the Impacts of Mental Disorders on Work Ability	To develop an efficient CDSS-assisted key process for work ability evaluation of mental and addiction care patients	A CDSS-assisted work ability evaluation of psychiatric and addiction patient process	A concise work ability evaluation of both psychiatric and addiction patient
P3	Clinical Decision Support System for Opioid Substitution Therapy	To develop an efficient CDSS-assisted key process for opioid substitution therapy patients	A CDSS-assisted opioid substitution treatment process of opioid dependent patient	A clear opioid substitution treatment process of challenging patient group
P4	Redesigning Mental Health Care Service Processes to Increase Productivity	To redesign/ reengineer the processes of traditionally fragmented and separated mental and addiction care	A designed integrated mental and addiction care model, procedural metrics	Concurrent care of mental and addiction disorders of patients
P5	Increasing Productivity in Mental Health Care Services with an Integrated Process and Diagnostics Support System	To study of the effects of integrating the processes of mental and addiction care with the diagnostic support system	A designed integrated mental and addiction care model, procedural metrics	Waiting lists disappeared, accessibility to care improved, the productivity of individual employee increased
P6	Improving the Productivity and Efficiency of an Integrated Mental and Addiction Care – An Application of the Theory of Constraints and Five-focusing Step to Evaluation of Adult ADHD Patients	To study the productivity and the efficiency of the application of the TOC and the 5FS to the adult evaluation process	A CDSS-assisted adult-ADHD patient process, procedural metrics	The constraints of the evaluation of the adult-ADHD process exploited and elevated

4.2 Redesigning integrated psychiatric and addiction care model

The last three publications (publications 4, 5 and 6) focused on developing, establishing, and sustaining the modern way of delivering care for mental and addiction patients, i.e. the MTPA model. The MTPA model was the answer to the increasing pressure to raise productivity with the existing resources in public health and social care in Finland. Also, when redesigning, the operating costs must decrease while the service level must be maintained or even increased. The budget requirements insisted on covering transformation incurs without extra allocation from sources other than the annual budget of the facility. The financial and other resources for the transformation of psychiatric and addiction care were reallocated by closing two out of four inpatient psychiatric departments. The released resources were allocated entirely to the development of an open ward, both mental and addiction care.

Before redesigning, the quality of care, motivation, and working morale of the employees and customer satisfaction needed improvement. The search for proper transforming management philosophies for new integrated mental and addiction care (the MTPA model) led to business process management, reengineering/redesigning, total quality management (BPM/BMR and TQM, see Hammer 1990, Hammer and Stanton 1995; Laamanen 2009; Mahal 2010; Champy and Greenspun 2010; Oakland 2011), and Lean Six Sigma, LSS (see Harrington 1991; George 2003; Chalice 2010; Arthur 2011a; Modig and Åhlström 2016; Kubiak and Benbow 2016; Munro et al. 2008/2015). The real value (in LSS sense) for the patient is a smooth, efficient, and effective care path in different service and treatment service systems. Also, the domains of health operation management (hOM, see Vissers and Beech 2005) and, to a lesser amount, organizational development (see Cheung-Judge and Holbeche 2015) were applied to the redesigning.

The common problems of health care were and still are the limited access to care, high and annually rising costs to society, and the lack of proper measurement and metrics of procedural activity in organizations. The number of implementation failures of organizational change is high, as about 2/3 of redesigning attempts fail. The whole health care system is full of disengagement, fragmentation, and complexity (Edmond et al. 2010, 759–760). These problems are partly solved by developing a new care delivery model, the MTPA model in this research. This new integrated mental and addiction care model was developed in 2011–2015 in the South Karelia District of Social and Health Services, which is located in the southeast of Finland. Before the MTPA model, the separate mental health and addiction care organizations had low productivity, long waiting lists, ineffective diagnostic processes, and a siloed functioning practice.

After benchmarking the practices of different mental health care clinics and their mapped processes in Finland, referrals appeared to be the bottlenecks of care accessibility. Traditionally, referrals have worked as a gatekeeping function from primary to secondary and tertiary care. Referrals usually increase the burden of busy general practitioners (Lipsitt 2010) who are the primary sources of psychiatric referrals. The traditional

organization of the open psychiatric ward (Heikkinen et al. 2008) is depicted in Figure 26.

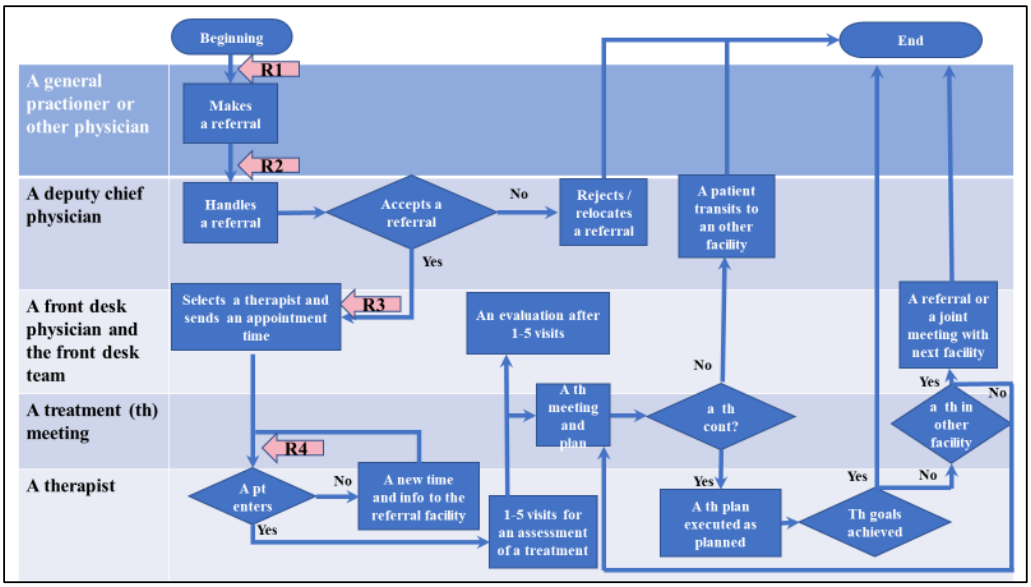

Figure 26: The traditional organization of the open psychiatric ward.

The arrows (R1–R4) demonstrate the course of the referral, which is handled four times before the patient sees a therapist. These four times hinder immediate access to care, which is a common concern and complaint of all shareholders of health care. Thus, referrals are not a necessity.

Before the transformation of mental and addiction care in South Karelia, the problematic accessibility to open ward mental health service systems created a common logistics problem faced in health care. The waiting time from the referral to the first appointment in 2008 is described in Figure 27 (previous chief senior psychiatrist of the mental health clinic 2010, personal communication), before redesigning mental health care delivery. Before the redesign, the mental health clinic had a five to nine weeks' waiting list in 2009 (Kemppinen et al. 2014). In addition to these five to nine weeks' waiting times to the mental health clinic, there was also two to four extra weeks of waiting to see the general practitioner or occupational health physician to get a referral to the mental health clinic (Kemppinen 2015).

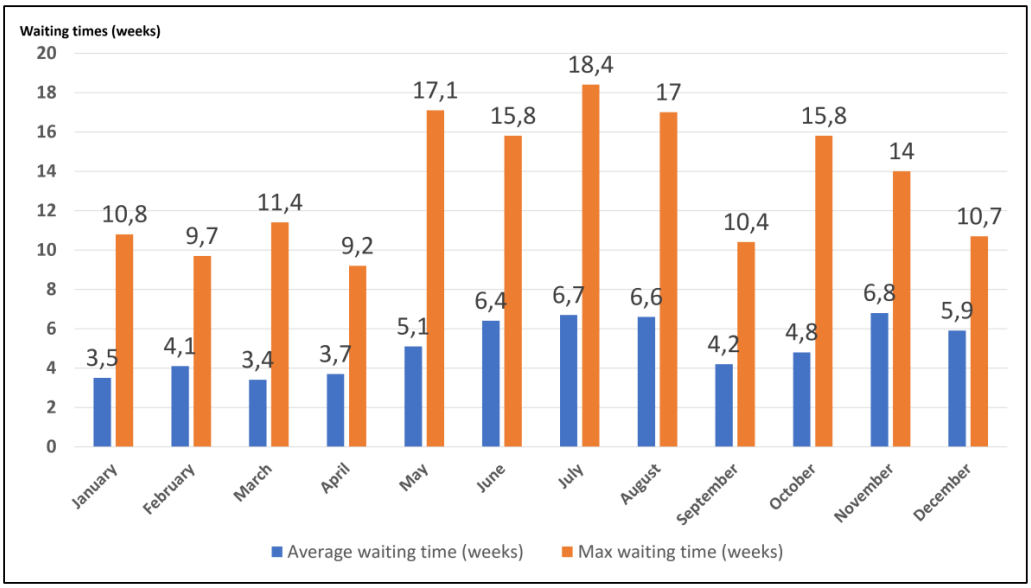

Figure 27: Waiting time (average and max in weeks) from referral to the first appointment in 2008.

In 2013, the National Institute for Health and Welfare (THL) published the initiative "Treatment without waiting", which was targeted primarily to primary care and its logistics problems. Usually, waiting list problems were worse in mental health clinics than in primary care service systems. Before the redesigning/reengineering of psychiatric and addiction care, waiting lists of five to nine weeks were common in psychiatric care and even longer in addiction care (Kemppinen et al. 2014). However, after redesigning the mental and addiction care delivery system to a walk-in type, there were practically no waiting times of over a week in MTPA (Figure 28). Over 50 per cent of patients got an appointment time at once if they needed one. Over 60 per cent of patients got their appointment time within three days, and 85 per cent got it in one week. Mostly, waiting times of over a week occurred when the patient wanted their appointment to take place the following week.

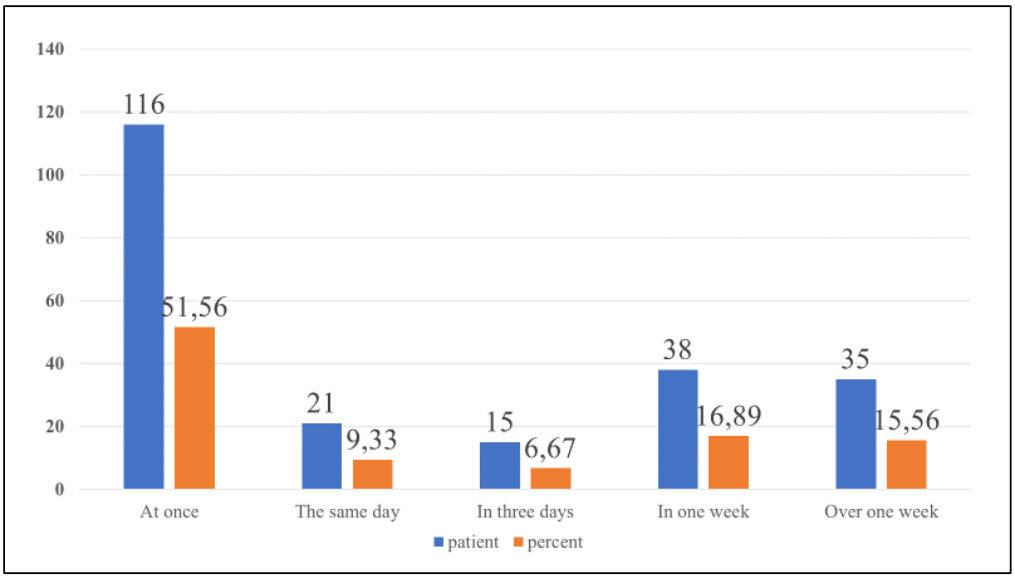

Figure 28: Waiting time to the first appointment in the survey (N=225) in November 2012 (Mirola et al. 2013, 18).

Previously, before the establishment of the MTPA, there was no proper process map depicting the entire care process of a patient. A nurse on call in a previous clinic had a paper sheet, into which she recorded the patient contacts. In two weekly meetings, she tried to find an employee who would agree to offer an appointment time for a patient. Being the nurse on call was an unrewarding post because every employee said that they did not have available appointment times. Thus, the nurse on call tried to see these patients by herself. The metrics of the daily appointment times of psychiatric nurses revealed that, on average, psychiatric nurses had 2.5 patients per day (Kemppinen et al. 2014). An evident and urgent need to redesign/reengineer the previous mental care process became visible. Figure 29 presents the redesigned/ reengineered and agile walk-in care process of the MTPA.

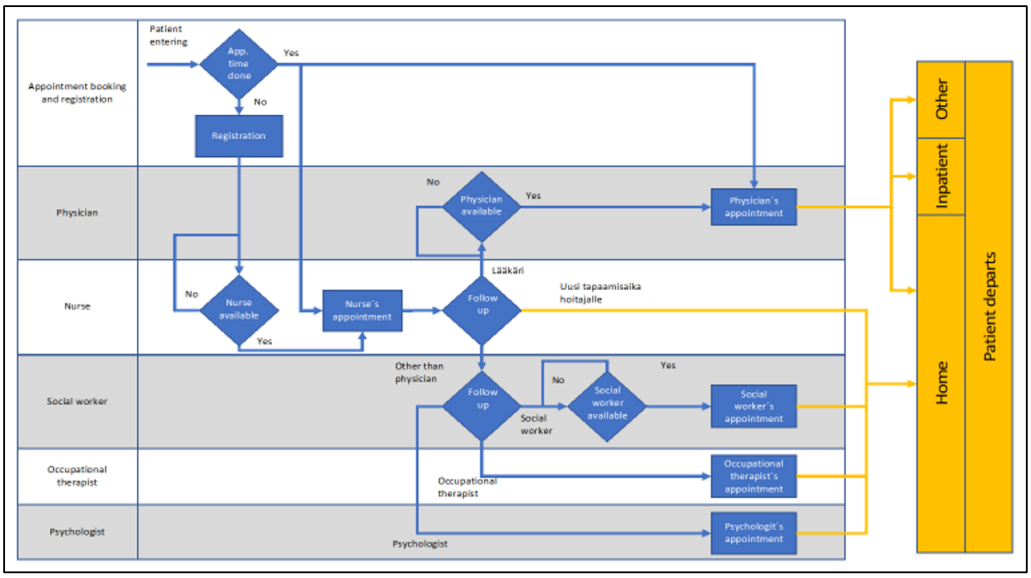

Figure 29: The agile walk-in care process of MTPA.

The agreed procedural metrics and key process indicators were planned to replace the previous leadership style which was based on personal relationships and mutual contact ("buddy management"). Also, the purpose was to replace the previous leadership practice where instantly emergent effects among discussants weighed more than the actual procedural metrics ("fact management") in the development of the organization. Without appointment time metrics, the employees stated that they had full schedules and usually no extra times for more patients. The procedural metrics of appointment times showed 2.0–2.6 visits per day per employee, which indicated very low productivity, which unfortunately is a standard feature of mental health and addiction care clinics in Finland. The first procedural metrics exposed that an average employee had 2.5 direct patient appointments per day (Kemppinen 2015). The productive objectives (a red dash in Figure 30) established an average of four direct patient contacts per day (Figure 30), which was consistently achieved in 2013.

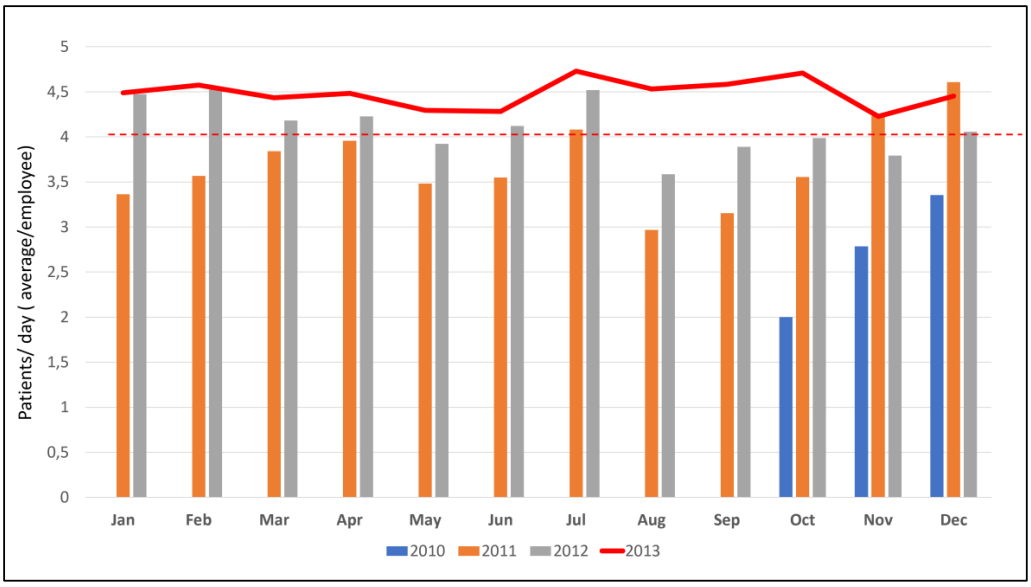

Figure 30: The productivity objectives (a red dash) and outcomes of MTPA in 2011–2013.

Before the year 2011, patients did not get appointments to mental health care service systems during daily working hours. Accordingly, they searched for consultation from the somatic emergency department after office hours. In the somatic emergency clinic of the central hospital of South Karelia, about 6 000 (13.3 %) of the 45 000 visits were labelled in triage E in 2009. Usually, these triage E patients needed a psychiatrist, addiction medicine, or social issue consultation. Furthermore, the psychiatric patient flow for inpatient departments outside office times increased annually in 2007–2009, 54, 65 and 72 per cent respectively, before the implementation of a new integrated mental and addiction care clinic. The established MTPA model diminished the patient flow in the evening and at night time and increased it during office hours in MTPA. The evening and night flow to the inpatient departments diminished after redesigning the care. The working hours of MTPA were initially extended to 9 pm, but even these evening times diminished after the implementation of the new model of care (Figure 31), because such few patients arrived at MTPA after 4 pm.

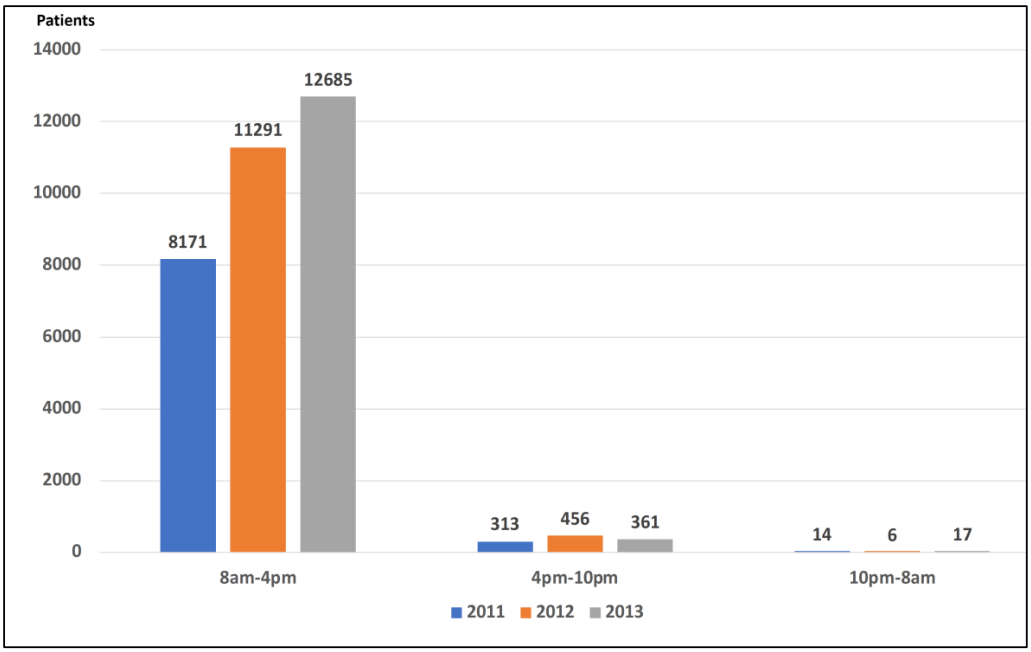

Figure 31: Patient visits in MTPA according to appointment times.

The design principle of the new integrated mental and addiction care clinic started from the needs of patients/customers (the voice of the customer). The voice of the customer (VOC) is a part of Quality Function Deployment (QFD) (Akao 1990), which is a total quality management process. The QFD is one of the common tools presented in the Lean Six Sigma. The Voice of Customer identifies, segments, and priorities customer needs. The goal of the QFD and the VOC is customer satisfaction. (Griffin and Hauser 1993).

The VOC is not as familiar a principle in organizing health care (McColl-Kennedy et al. 2017), as it is in business case development in other industries. Usually, health care is designed and arranged based on the preferences of the employees of health care. The root causes of low productivity were scrutinized and several solutions to assist the logistics of the patient flow invented. The paper appointment scheduling system (a paper notebook and paper calendar of an employee) were replaced with an electric one. All appointment times of all employees were transparent to the whole personnel of integrated mental and addiction care. The front desk nurses on call had the privilege to schedule an appointment for patients instantly to every employee (the chief psychiatrist included). They were responsible for the incoming patients. However, usually, they do not have the authority to make the decisions necessary for an agile patient experience. Responsibility and authority were combined. Previous experiences revealed that the nurse on call was easily left alone with an emergency patient, being solely responsible for booking the next appointment, which caused reluctance to work as a nurse on call.

The disadvantage of the walk-in principle was missed appointments, which is a common phenomenon in health care (Kaplan-Lewis and Percac-Lima 2013). Usually, the first appointment is a referral-free, walk-in appointment in the MTPA. After the first walk-in appointment, care continues as elective appointments. These elective appointments of walk-in patients constitute a substantial waste of resources. Figure 32 shows the missed visits and patients in MTPA in 2011–2015. The average amount of visits per nurse in public care (holidays, education, and meetings excluded) is about 800 visits per year. Accordingly, about three and half years of an FTE's (the full-time employee) resources were lost to missed visits because of the lost appointment times. The public service in MTPA was free to the patients. No charges were billed for the missed visits. The persons who miss their visits are often suffering from addiction or/and personality disorders.

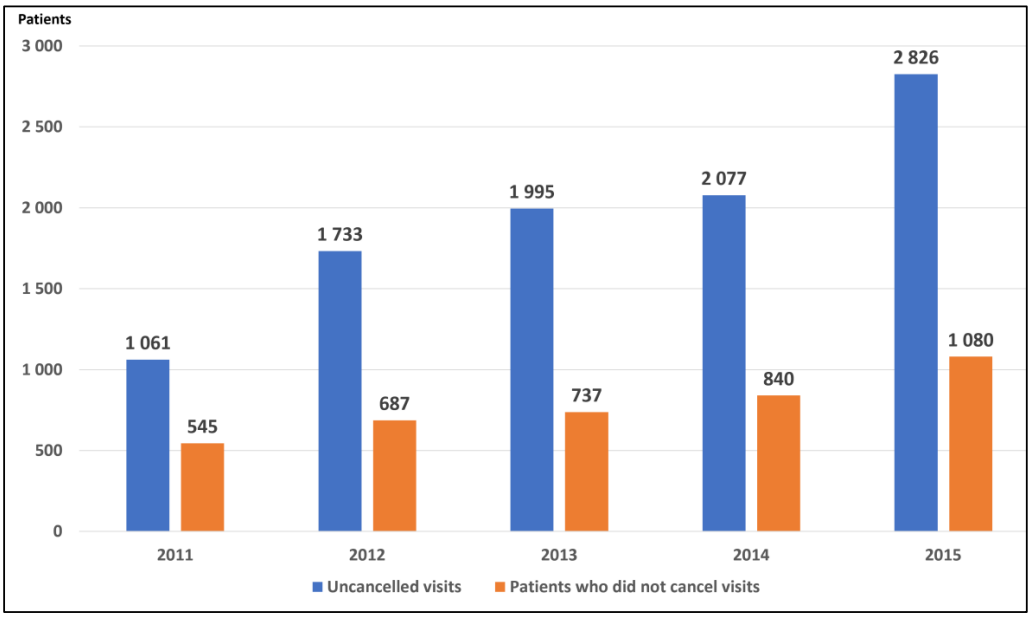

Figure 32: Missed visits and patients in MTPA in 2011–2015.

Multiprofessional teamwork has been taken granted in health care, especially in mental, addiction, and social care. The root cause analysis revealed that one reason for inefficiency was too many meetings, which exploited the resources of the mental health clinic. According to Nelson et al. (2010, 144), in multiprofessional teamwork, approximately 53 % of all time was spent in meetings, which was unproductive, worthless, and of little consequences. Because of too many meetings, most direct appointment times took place in the afternoon. In the redesign process, the meeting practice was altered. The meetings without a clear agenda and without those who can make decisions to were cancelled altogether. The memos were written in the meeting and disseminated at once to the intranet pages. One clinic had a habit of dealing the referrals

among 20 employees in one hour, at the beginning of every working day. Eliminating these "morning meetings" freed up about 500 more working hours per month for direct appointment times.

The performance output measures (Vissers and Beech 2005, 2–3) of patient satisfaction were monitored in November 2012. The local university of applied sciences (Saimia) surveyed patient satisfaction (Mirola et al. 2013, 20) in Eksote. The ten questions surveyed the quality of patient care. An item was considered successful when it received a minimum rating of three in Figure 33. The survey included four other service systems of Miete (Miete was the name of all the mental and addiction care units). In addition to MTPA, the survey included a day care rehabilitation unit, a nursing home, an addiction patient clinic (a part of MTPA), and a local mental health clinic (not a part of MTPA). The results of the survey are presented in Figure 33.

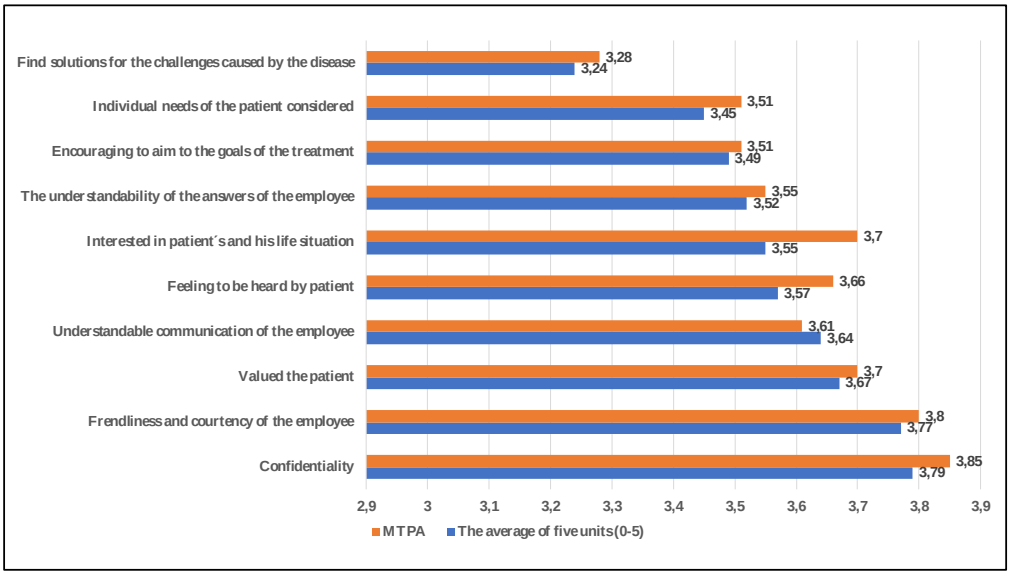

Figure 33: The patient satisfaction survey in MTPA and the average of all Miete service systems in November 2012 (Mirola et al. 2013)

A substantial organizational transformation was executed from the traditional separated mental health and addiction clinic into an integrated mental and addiction care clinic, and, the results of the employee satisfaction survey were excellent in the research period (for example, in 2014 in Figure 34). The satisfaction for wages was the only item out of the nine that was below the strategic objectives (which was three (a red dash in Figure 34) or above three in each issue in the whole organization) of the entire organization.

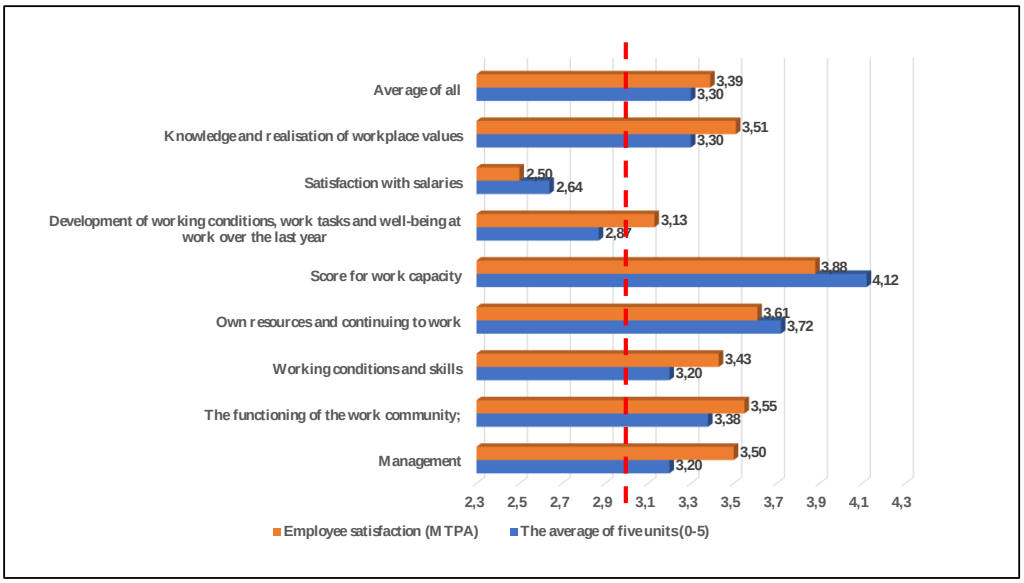

Figure 34: The employee satisfaction survey in MTPA and the average of all Miete service systems in January 2014.

The sick leave allowance statistics (Figure 35) from MTPA in 2011–2015 (the number of employees increased with the integration of mental and addiction care) were also moderate in the public sector. Sick leave days are higher in the public sector than in the private sector in general. In 2011–2015, the average sick leave absences in Finnish municipalities per person were 18.3, 17.2, 16.7, 16.9, and 16.5, respectively. Thus, sick leave absences were below (except in 2012) the prevailing trend in that period (https://tyoelamatieto.fi/#/en/dashboards/kunta10-sick-leave). The most common reason is the long sick leaves of a few employees. The sick leaves increased only in certain individual employees, and the turnover of employees was exceptionally low during 2011–2015.

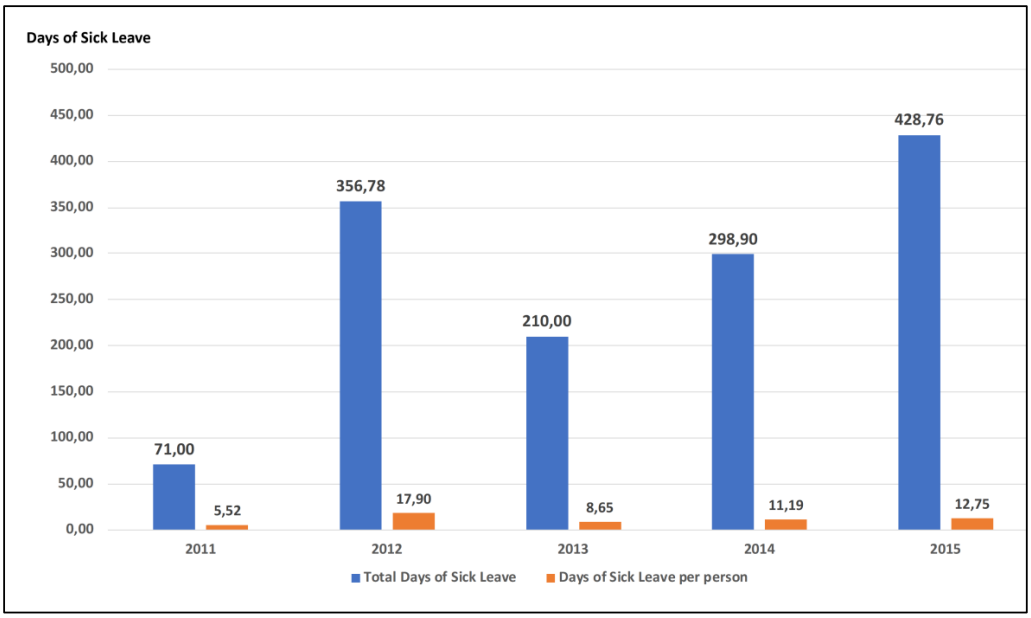

Figure 35: Sick leave allowance days (total and per person) in MTPA in 2011–2015.

The CDSS-assisted key processes were mapped, streamlined, and executed to present further areas to develop in the MTPA model – multiprofessional teamwork which was the focus of publication 6. The culture of mental health and addiction care without processes and process organization usually carries a craftmanship artist attitude where individual efforts, substantial autonomy, and independence dominate. Usually, specialized employees (psychologists, occupational therapists, and social workers) in mental care units develop their habit of executing their daily chores, which are not aligned with the entire process. The output of psychologists and occupational therapists is about two patients per day. These low procedural metrics easily result in the long lead times of the various processes in question. Without proper coordination and use of a specific mechanism (for example, the TOC and 5FS, see Goldratt and Cox 1984/2014) to increase efficiency, a standard multiprofessional team on average handled only two patients per day. The TOC-challenges in the adult ADHD patient service process (a multiprofessional team and other similar joint processes in social and health care) are presented in Figure 36).

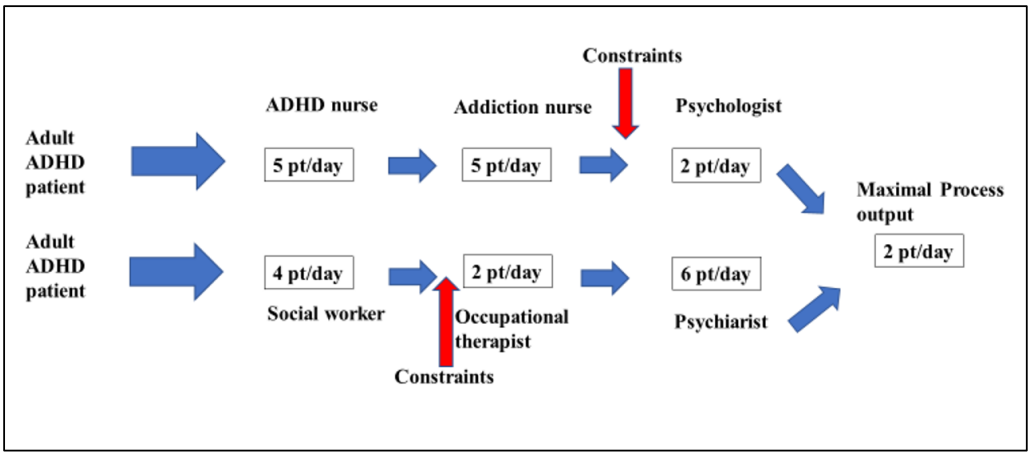

Figure 36: The critical supply chain model of the adult ADHD patient service process.

To summarize, in this research, a new integrated mental health and addiction care clinic (the MTPA model) was established. A process-based organization with three CDSS-assisted key processes (adult-ADHD, working ability assessment of the mental and addiction patient, and opioid substitution assessment) was designed. The processes were mapped and streamlined, and a Serena platform CDSS designed. The principles of business process management (BPR), Lean Six Sigma (LSS), and theory of constraints (TOC) were applied successfully to the development of the MTPA organization. Also, organizational development (OD) and health operation management (hOM) theories provided an additional background for the development efforts.

Table 10: Summary of Figures 26-36; the main issues and objectives and conclusions presented.

	Main issues or objectives	**Conclusions**
Figure 26	Too many handoffs of a referral	No referrals, faster accessibility to care
Figure 27	Long waiting list	No waiting lists
Figure 28	Long time to the first appointment time	Over 60 percent in the same day
Figure 29	No mapped processes	Key processes mapped
Figure 30	Low productivity, about 2.5 patient / day/ an employee	Over 4 patients / day / an employee
Figure 31	Patient overflow after daily working hours	Patient treated about 95 percent in daily working hours
Figure 32	Missed visits to employees	increased missed visits, easy accessibility
Figure 33	Patient satisfaction objectives	Objectives achieved
Figure 34	Employee satisfaction objectives	Objectives achieved
Figure 35	Redesign / reengineering does not cause the increase of sick absence leaves	Sick leave absences below the average of employees in Finnish municipals in 2011-2015
Figure 36	The productivity barriers of the multiprofessional team inspected	The constraints of one key process (an adult- ADHD) exploited and elevated

5 Conclusions

This chapter summarizes and discusses the main findings of this dissertation. The theoretical and practical findings of this dissertation are presented. This dissertation mainly makes a substantial contribution to effectively implementing a new way of developing, organizing, and implementing integrated mental and addiction care. The theoretical contributions offer a new perspective and a different way of thinking and theorizing integrated mental and addiction care.

5.1 Contribution to the theory

Firstly, systems and process thinking and organizational development approaches (reengineering/redesign and Lean Six Sigma) were applied to the design of the three new clinical decision support systems to solve problems of previous mental health care in South Karelia in the southeast of Finland. The key processes of the MTPA business were managed, and these three CDSS artifacts (adult-ADHD, the working ability evaluation of mental and addiction care patients, and the opioid substitution therapy assessment) were designed. The designed CDSSs worked in the real world and are applicable also to other real-world environments (Hevner et al. 2004, 98), where they were developed. In previous literature, systems and process thinking and organizational development approaches (reengineering/redesign and Lean Six Sigma) were not found in developing integrated mental and addiction care.

Secondly, this dissertation introduces a new concept, an integrated walk-in mental and addiction clinic (MTPA), which differs from the traditionally organized separated service systems of mental and addiction care. The MTPA model was not to increase the on-site psychiatric care opportunities in primary care (Vickers et al. 2013; Pomerantz et al. 2008), which we had also taken into consideration when designing complete mental health services. MTPA was conceptually closer to secondary care without referrals than primary care with on-site psychiatric services. This dissertation disseminates the results from combining two fragmented and inefficient systems of mental health and addiction care into an agile, queue-free, and referral-free service for these commonly neglected patient-groups, mental and addiction care patients. The designed and developed concept, the MTPA model, forms an asset for scientific management (Taylor 1911; Hammer and Stanton 1995; Modig and Åhlström 2016). The achievements of the MTPA model solved some persistent wicked problems of health care, i.e. the waiting list problem (Luck et al. 1971; van Dijk 1996; Vissers et al. 2001) and low productivity issues concerning mental health care in this research project. This dissertation contributes to the literature of organizing health care services in general and organizing mental and addiction care services in particular by providing the MTPA model.

Thirdly, this dissertation depicts how to develop from organizational silos to a process-based organization that operates in a process-centred (W.E. Deming's ideas in Harrington 1991, 5), not in organization-centred, thinking. Field problems drove the research

questions (RQ1–3) of this dissertation, and this research aimed at solution-oriented knowledge to solve these problems by identifying the key processes, their design supported by the designed artifacts (CDSSs). The justification of the research results was based on pragmatic and external validity because the designed CDSSs can be quickly implemented in new working environments. This dissertation presents a general blueprint with an expert system, the clinical decision support system, to solve real-life problems of siloed and fragmented mental and addiction care.

Fourthly, this dissertation offers a concise presentation of self-evident "multiprofessional teamwork" in mental and addiction care by providing an accurate description of the roles, tasks, activities, and tools of the key processes of a multiprofessional team in integrated mental and addiction care. The dissertation provides an easy blueprint (the CDSS artifacts) to develop coordination in multiprofessional teams and improve individual skills in the multiprofessional teams of mental and addiction care.

5.2 Contribution to the practice

This dissertation demonstrates how traditionally separated mental and addiction care developed into integrated care. This dissertation depicts how the efficiency and productivity of the workflow in mental health and addiction care service systems improved. This research presents how diagnostics processes can be standardized. Also, this dissertation provides an example of improving information flow and coordination in multiprofessional teams. The reporting capabilities of the designed, developed, and implemented CDSS create the basis for effective process management and development.

Firstly, this dissertation provides practical insights into and recommendations on how to make a system development by redesigning traditional psychiatric and addiction care. Service design is profoundly important for the outcomes of health care. Service design accounts for 70–90 per cent of the outputs and results of the organization (George 2003; Bohmer 2009). The traditional design template of mental and addiction wards is history, and a new way of organizing integrated mental and addiction care must be developed (McColl-Kennedy et al. 2017). It does not help to produce small incremental changes in the old design of care. It is impossible to make the necessary changes in the old structures of mental and addiction care. It is quite surprising that the traditional way of organizing mental and addiction care have not been questioned more, regardless of the frustration toward the current system acknowledged by all stakeholders. This dissertation provides one efficient and provably productive option of redesigning integrated mental and addiction care, which has for decades been one of the main initiatives of the Ministry of Social Affairs and Health in Finland. The MTPA model offers a general template for developing integrated mental and addiction care.

Secondly, the designed CDSS offers a practical way of establishing a platform for new teams to promptly organize themselves. They familiarize new staff with the processes of the organization. Each member (new or old) of the multi-professional team can easily participate in the processes without interruptions, which are common in situations where

the members of a multiprofessional team have changed. The most serious and, unfortunately, conventional disruption for teamwork is the changing of a physician. Usually, the entire multiprofessional team tries to accommodate the idiosyncrasies of the changing physicians, which effectively paralyzes the entire team for a long time. The designed CDSSs and their written roles and responsibilities offer a standard and continuing ground to develop the multiprofessional teams, even in situations where one or more members of the team change.

Thirdly, this dissertation offers a practical solution to other common problems in mental health and addiction care clinics. The scheduling and queue challenges are habitual in any open ward clinic. The available electrical appointment times, even when chosen by patients themselves from their devices (phones, pads, or PC), visualize the daily schedules, queues, and logistics in a way that the current patient flow is easily visually understood. The electronic scheduling calendar in which appointment times are visible to all team members works as a visual kanban. Also, it shows at once which employees are free and available to take patients if there are queues or other exceptional situations (or other gemba-issues) at the front desk of the walk-in clinic. A frequent problem for on-call psychiatric nurses in the previous organization was the difficulty in receiving support in these overload situations with the need to handle several emergency cases at the same time. The nurse on call has the responsibility and the power to ask immediate help from any employee who does not have a patient at the time. Before, the nurse on the call had to beg other employees to come and meet the patient, which was one of the reasons being on call was not a particularly wanted task. The open calendars of the whole team diminish the possibility of overburdening those employees who already take on more responsibilities than others. It diminished the risk of burning out and removed unevenly distributed responsibilities as a source of dissatisfaction. The jidoka principle (in 1896, Sakichi Toyoda invented a simple device with which anyone can stop the conveyor belt if problems emerged) applied to an integrated mental and addiction care clinic empowered each employee to take responsibility for the smooth operation of the clinic.

Finally, electronic medical records (EMR) are usually full of information and disinformation, and they are disintegrated. The problems of procedural data surfaced when visits, diagnoses, and patient amounts were scrutinized. The diagnostic code Z00.4 was used for the issue of prevalent disinformation of patient data. In ICD-10, these diagnosis codes meant an unspecified psychiatric visit. In practice, this meant there was no information at all about the patient visits. The incentive for the prior coding instructions was that care staff other than physicians who are responsible for diagnosing patients could continue recording the patient information in the EMR. At the beginning of the MTPA model, about 10 000 of the 18 000 yearly visits were diagnosed as Z00.4, which made it challenging to determine what kinds of patients had visited in MTPA. After the new instructions, there were only 300 Z00.4 diagnoses in the next year. The instructions for logging diagnoses were distributed, and all employees logged the diagnosis of the patient at the general level, which helped in retrieving information and proper procedural and other metrics about the operations in MTPA. The lack of up-to-date and visible-to-all (for example, how many patients each employee has per day does

not exist) information of production metrics does not exist habitually in mental and addiction care in Finland. In Finland, about sixty percent of taxes collected are spent in social and health care. Deming's famous adages say: "What you cannot measure, you cannot control, what you cannot control, you cannot manage," and "If you cannot measure it, you cannot improve it."

5.3 Limitations

The purpose of this dissertation has been to facilitate organizational change and solve the daily problems of a newly established integrated mental and addiction care facility. As a design science enterprise, it tried to build several artifacts to solve real-world problems. As a chief senior psychiatrist, the researcher has been both an insider (executed and established the necessary operational changes with the team in a clinic studied) and an outsider (as an organizational development researcher studied the redesign) in the service systems where these artifacts have been developed, implemented, and iterated.

Being in a superior and authority position to those with whom these artifacts were implemented have had both positive and negative influences. One of the positive influences was that over 30 years of experience from the field studied as an insider affords deep explicit and tacit knowledge of the research area. Work as chief senior psychiatrist in three different areas in Finland in 2011–2019 has opened up opportunities and challenges to apply and implement the MTPA model and the CDSS-artifacts in practice. The culture and history of the clinic affect a lot of the possibilities to execute fast and agile changes in mental and addiction care practice. As a matter of fact, the culture and history of individual clinic enable or preclude necessary changes. Finally, the necessary daily decisions made as chief senior psychiatrist in regular daily routines may have shortened sight and time to take advantage of all discussions and development ideas provided by the employees. Also, patients could have consulted explicitly or asked to participate in the focus groups. Despite a lot of redesigning/reengineering activities depicted in this dissertation having been worked out in many discussions with patient encounters and in shared duties with fellow employees in ordinary daily working life and focus groups, the final interpretations and conclusions about those redesign activities belong to the researcher. These interpretations and conclusions have been drawn from the partially subjective perspective of the researcher.

If the ensemble problem of the bidirectionality between the Serena platform and the Effica (the EMR in use) were solved, the full potential of the CDSSs could be realized and the further development and iteration of the other processes of MTPA enabled. Also, the whole enterprise architecture could have helped broaden the possibilities of the CDSSs. If more solid statistics had been available, the quantitative analysis and interpretation could have broadened the quantitative robustness of the results of the dissertation.

Pyzdek and Keller (2014, 118) warned about process improvement versus system optimization in the words of Deming: "[…] maximizing local efficiencies everywhere in a system is not necessarily a good thing to do." The whole system optimization, in this

setting, in the entire South Karelia District of Social and Health Services could have assisted in the efforts of this dissertation. As lessons learned from the efforts of the Total Quality Management (Oakland 2014), Reengineering (Champy and Greenspun 2010), and Lean Six Sigma (Cohen and Dahl 2010) approaches, the organization-wide changes are the most sustainable ones. Also, the implementation of the CDSS needs to be an "ongoing process at the organizational level" (Porter et al. 2018). Without the entire organization involvement of the process improvement, the suboptimization of local efficiencies dominates.

The MTPA-model and the CDSS-artifacts are easily applicable in Finland and the Nordic countries. The CDSS-artifacts are applicable and further developable globally. However, the MTPA-model needs to be adapted to the local health care system in general and mental and addiction care in particular.

5.4 Suggestions for further research

This dissertation focused on developing and implementing a new way of organizing integrated mental and addiction care in the southeast of Finland, the South Karelia District of Social and Health Services. The implementation of the developed model had also been tried in another south-eastern city, Kotka, which is a city about 200 kilometres from Lappeenranta, where MTPA was originally established. The employees of integrated mental and addiction care in Kotka did not want the MTPA model, because they trusted the traditional way of organizing mental and addiction care services. Also, an enterprise to implement a similar MTPA model started at the beginning of 2018 in Vaasa, which is located in Western Finland and has a different bilingual (Finnish and Swedish) local culture. The population of Ostrobothnia (Pohjanmaa in Finnish) is about 180 000, which means that the amount of inhabitants is roughly the same. The MTPA model was applied to these two places, offering iterative results for analysing the benefits and deficiencies of the model. The experiences from the process improvement efforts in all three culturally different areas in Finland have broadened the knowledge of local political and cultural assets and deficiencies in organizational change. The local political and cultural aspects of the organizational change could be an interesting research area.

The experiences of implementing the MTPA model have confirmed the advantages of lean thinking and also confirmed that flow efficiency is better than the traditional resource efficiency in organizing mental and addiction care. (Modig and Åhlström 2016). Also, these experiments open further research areas for service design (Curadale 2016). The service design ideas form a necessary part for implementing new health care service systems according to lean (Womack and Jones 2003) and system thinking. In addition, the advantages of the MTPA model are better than the traditional organizational profile in organizing mental and addiction care in terms of the third, sixth and seventh criteria of the seven Baldrige criteria of health care. The famous quality prize Baldrige criteria are 1. Leadership, 2. Strategic planning, 3. Focus on patients and other customers, 4. Measurement, analysis, knowledge management, 5. Staff focus, 6. Process management,

and 7. Organizational performance results (Edmond et al. 2010, 765). The further research could include organizational development efforts to meet the Baldrige criteria. Therefore, the quality efforts of the entire quality management system (QMS) for mental and addiction care according ISO 9001 for health care (Levett and Burney 2014) could be an interesting research area.

The CDSS formed individual support systems which helped in the daily chores but it should be expanded to the entire enterprise architecture for mental and addiction care. This dissertation and implementing the MTPA model witnessed the need for an overall architecture for a clinical decision support system. Individual clinical decision support systems should be built in coherent systems which could provide support for the whole electronic medical system (EMS). Open access and code requirements for individual interfaces could help in developing clinical decision support systems without vendor-lock-in syndromes. The enormous number of different systems already functioning in ordinary hospitals (according to personal communication from chief information officer Toni Suihko, 200–600 different programmes in the South Karelia District of Social and Health Services) requires the development of a more concise ecosystem for the entire IT-system of hospitals. It may be impossible to maintain such an amount of different IT-programmes effectively. The efficient ecosystem of IT-programmes, which also includes other public service systems (unemployment and social security authorities), could diminish the inefficiencies faced in handoffs between these organizations. The new techniques of decision-making offer new areas for research: Artificial Intelligence (AI) techniques, machine learning, particle swarm optimization, fuzzy logic, agent grid, visualization user interface (VUI), data mining technology, sequential pattern mining (SPM), search patterns, the Genetic Algorithm (GA) and artificial neural networks (ANN).

Furthermore, health care is full of all kind of information which is fragmented, unmonitored, unanalysed, and unused. The measurements and metrics of health care are better used when all patient records written by individual employees are instructed and monitored more closely. The current recording of patient information in health care is better than in social care but much is still needed to manage EMSs more closely for the usefulness of forming knowledge that would guide further development in mental and addiction care. The old adage maintains that what you cannot measure, you cannot manage, and what cannot manage, you cannot govern. The necessary output increases in productivity, efficiency, and even in effectiveness are not possible without proper statistics on the current production of mental and health care. The clinical indicators of the patient are not enough for the governance of modern health care. Several data mining and data warehouse applications have been developed. Also, business analytics and prediction analyses of health data increase. The efficacy, productivity, and especially effectiveness of health care organizations form a tempting research area.

Also, Zimmerman et al. (2008, 3–14) claimed that health care needed a new way to conceptualize its delivery processes. They stated that health care leaders no longer trust the old management theories nor strategic plans. The implemented change of the

organization was useful in one context, but it would not be in another one. They emphasized that the old management doctrines do not apply to the current health care context, which is not a Newtonian machine (clockware). Complexity science offers a better organizational metaphor of a living organism, a complex adaptive system (CAS), which is an emergent, unpredictable, disorderly, unstable, and nonlinear system. The complex adaptive system is not ahistorical, and even a small input, the butterfly effect (E. Lorenz), facilitates substantial changes in an organization. In a nonlinear system, the magnitude of change cannot be predicted accurately. Complexity science combined the tenets and approaches in this dissertation into a potentially fruitful mix of theoretical approaches.

In conclusion, Järvinen (2007, 52) claimed that "the transition from the problematic state to the desired state is a unique, hopefully irreversible or sustainable". Similarly, Van Aken (2004, 241) claimed about sustainable changes in organizations: "In this respect an organization can be compared with a garden, as artifact created through the designs and hard work of the gardener and as natural system developing under the influence of sun, rain, soil conditions, insects etc. (and in some gardens the gardener tries to control natural development as best as he/she can, while in others the gardener leaves more to Mother Nature)." If the fundamental changes in any organization require enormous effort, then to sustain these – hopefully desired – changes, the same or even more effort is needed when the organizational defences (Argyris 1990) step in. How to sustain the positive gains of the organizational change in the turnover of personnel in the turbulent future of health care provokes the researching mind. Besides, the search for hidden performance metrics of social and health care fascinates the curious mind.

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Publication I

Kemppinen, J., Korpela, J. Elfvengren, K., Salmisaari, T., Polkko, J. and Tuominen, M.
A Clinical Decision Support System for Adult ADHD Diagnostics Process

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A Clinical Decision Support System for Adult ADHD Diagnostics Process

Juha Kemppinen
Eksote, Valto Käkelän katu 3,
FI-53100 Lappeenranta, Finland
juha.kemppinen@eksote.fi

Jukka Korpela
Roce Partners,
Tekniikantie 14, FI-02150
Espoo, Finland
jukka.korpela@roce.com

Kalle Elfvengren
Lappeenranta University of
Technology, Skinnarilankatu 34,
FI-53850 Lappeenranta, Finland
kalle.elfvengren@lut.fi

Timo Salmisaari
Eksote
timo.salmisaari@eksote.fi

Jussi Polkko
Roce Partners
jussi.polkko@roce.com

Markku Tuominen
Lappeenranta University of
Technology
markku.tuominen@lut.fi

Abstract

Adult ADHD is a complex neuropsychiatric disorder, which is affecting the daily lives of 2-5 % of the adult population. This paper introduces a Clinical Decision Support System for diagnostics of ADHD. The introduced CDSS is currently in use in the South Karelia District of Social and Health Services (Eksote) in Finland. Eksote needed to establish the program for adult ADHD patients, and an evaluation, diagnosis and treatment process by a multi-professional team was developed. The new process was launched with tailor-made CDSS software support. The developed CDSS supports the implementation of the new adult ADHD patient evaluation, diagnosis and treatment process. The CDSS guarantees that the multi-professional team has from the start an algorithmic and extensive approach to the treatment of adult ADHD patients. The CDSS also warranted that Eksote has established a standard for the care of adult ADHD patients. The CDSS enables the possibility to make quick changes and development in the process.

1. Introduction

Adult ADHD (attention deficit hyperactivity disorder) is a complex neuropsychiatric disorder, which is affecting daily lives of 2-5 % of adult people. 10-20 % of people with common mental health problems have ADHD and 20 % of parents of ADHD children have adult ADHD [1]. An adult ADHD-patient has continuously difficulties in organizing, prioritizing and getting things started. He or she has difficulties in focusing, sustaining and shifting attention. Adult ADHD is currently underdiagnosed and undertreated in many European countries. Adult services for people with ADHD remain relatively scarce despite strong evidence for the benefits of diagnosing and treating ADHD in adults. [2]

Effective management of adult ADHD patients is justified from a health economic perspective since undiagnosed and untreated ADHD will lead to inefficient health care use, less satisfactory clinical outcomes, lower personal well-being and poorer social and professional interactions.

This paper presents a Clinical Decision Support System (CDSS) for effective diagnosis of adult ADHD patients. The goal of the developed CDSS was implement a new adult ADHD patient evaluation, diagnosis and treatment process.

The introduced CDSS is currently in use in the South Karelia District of Social and Health Services (Eksote) in Finland. Eksote arranges secondary health care, primary health care, care for the elderly, and social welfare services for its eight member municipalities. Eksote works for delivering patient-oriented care to the approximately 130 000 citizens of South Karelia. It employs approximately 4 100 people and has a budget of 370 million euros. Eksote operates in a geographical area of over 5 600 square kilometres.

2. Attention deficit hyperactivity disorder

Current advances in cognitive neuroscience, neuroimaging, and behavioral and molecular genetics have provided evidence that the attention deficit hyperactivity disorder (ADHD) is a complex neurobiological disorder. ADHD is a neurocognitive behavioral developmental disorder most commonly

seen in childhood and adolescence, often extending to the adult years. The ADHD prevalence was once estimated to be 3 to 5% of school-age children, but more recent studies place the figure closer to 7- 8% of school-age children and 4-5% of adults. [3]

People with ADHD often have serious impairments in academic, social and interpersonal functioning. An adult ADHD-patient has continuously difficulties in organizing, prioritizing and getting things started. The patient has difficulties in focusing, sustaining and shifting attention. He/she has difficulties in regulating alertness, sustaining effort and determining processing speed. He/she has daily difficulties in managing frustration and modulating emotions. He/she has problems in utilizing working memory and assessing recall. He/she has challenges in monitoring and self-regulating actions. These cognitive functions interact to serve as the management system of the mind. [4]

People suffering from adult ADHD are stereotyped as lazy, bad or aggressive. They are considered to have a behavioral or special needs problem instead of a mental health disorder that requires treatment. Clinical pictures of adult ADHD vary with age and gender. Clinical presentation of ADHD may vary according to age and stage of development and there are cultural differences in the level of activity and inattention that are regarded as a problem. Adult ADHD is currently underdiagnosed and treated in many European countries. Adult services for people with ADHD remain relatively scarce despite strong evidence for the benefits of diagnosing and treating ADHD in adults. [2]

Diagnostic criteria of adult ADHD include four main criteria [5]. Diagnosis requires that there should be clear evidence of clinically significant impairment in social, academic, or occupational functioning [6]. The diagnosis of ADHD in adults is a complex procedure which should include retrospective assessment of childhood ADHD symptoms either by patient recall or third party information, diagnostic criteria according to DSM-IV, current adult ADHD psychopathology including symptom severity and pervasiveness, functional impairment, quality of life and comorbidity. ADHD rating scales can be very useful for establishing a systematic database to support diagnosis and evaluation [7].

Adult ADHD is associated with several comorbid condition and disorders such as mood and anxiety disorders, substance abuse disorders, disruptive behavior disorders and learning disabilities [3]. Co-morbidity is the rule, with 75 % of clinical patients having at least one other psychiatric disorder. The mean number of comorbidities is three. Adult ADHD patients have mood, anxiety, sleep, conduct and substance use disorders and personality disorders. Undiagnosed ADHD in substance use disorders population has been estimated to be 11-54 %. Thus evaluation of co-morbid psychiatric disorders is a key component of the ADHD assessment using appropriate clinical diagnostic approaches [1][8]. Without comorbidities, 'uncomplicated' ADHD exists in about 20 to 25% of adults with ADHD. Even relatively successful treatment of the ADHD symptoms may be associated with only modest functional improvements in the real world. Diligent attempts to clarify the co-occurring conditions and related features (for example, poor social skills, low academic abilities) become essential in cases resistant to treatment [3].

Diagnosis of adult ADHD patient should include, according to the European consensus statement of adult ADHD, extensive psychiatric workup: detailed account of the developmental history, both current and retrospective account of ADHD symptoms and impairment and associated co-morbidities, before starting the treatment. The consensus statement proposes that diagnostic and treatment services for adult ADHD should be established throughout Europe [3]. However, education about adult ADHD has not been included in most college courses for medical and psychology students or in the training of professionals in adult mental health. Referral to specialist clinics should be possible where secondary care physicians lack sufficient training for more complex cases [1].

Pharmacological treatment is the treatment of choice in adult ADHD. Pharmacological treatment and early diagnosis have a positive impact on outcomes, long term prognosis, and quality of life in adults with ADHD [9].

The poor long term prognosis of untreated adult ADHD has implications for the costs of illness. In health economic assessments, costs are usually divided into direct and indirect costs. Direct costs refer to consumption of resources as a direct consequence of a state or disease, such as medical treatment. Indirect costs refer to indirect consequences due to a state or disease, such as the inability to perform work, thereby resulting in costs to society due to production loss. It is often the case that all costs and sacrifices of relevance from a societal perspective are not included in the assessments due to the difficulties in measuring and quantifying them. Examples of costs that are often omitted are the time relatives spend in giving care and support, psychological distress of patients and relatives (intangible costs), etc. Annual costs to society, excluding production losses due to inability to work, are work-impeding psychosocial problems 10600 euros (30 years 254 350 euros), mental illness 37 250 euros (30 years 916 100 euros) and drug abuse 66 000 euros (30 years 1 620 050 euros). [10]

Effective management of adult ADHD patients is justified from a health economic perspective since undiagnosed and untreated ADHD will lead to inefficient health care use, less satisfactory clinical outcomes, lower personal wellbeing and poorer social and professional interactions.

3. CDSS for mental health care literature review

Decision support systems (DSS) are computer technology solutions that can be used to support complex decision-making and problem-solving [11]. The fundamental task for DSS is to help decision makers in building up and exploring the implications of their decisions [12]. One subcategory of DSS is Expert Systems. An expert system is a computer system that emulates the decision-making ability of a human expert [13]. Among many fields in which Expert System is involved, medicine holds a large domain [14]. There are specialized expert systems used as decision support for different areas in medicine, and these systems are also known by general term Clinical Decision Support Systems (CDSS). Clinical Decision Support Systems are "active knowledge systems which use two or more items of patient data to generate case-specific advice" [15]. According to Sim et al. [16] CDSS is software that is designed to be a direct aid to clinical decision-making in which the characteristics of an individual patient are matched to a computerized clinical knowledge base, and patient-specific assessments or recommendations are then presented to the clinician and/or the patient for a decision.

CDSS has become increasingly more popular worldwide [17]. The advantages of CDSS include automation of a diagnosis process and the objective measurements and observations of selected parameters. CDSS provide support to the decision-making process, but it do not make any actual decisions; the role of the clinical expert is fundamental in the decision making [18]. However, there is a demand for a flexible, user-friendly and effective platform for the intelligent support of diagnostic medical decisions [19]. In addition, all clinical decisions are complex, but compared to other aspects of health care, psychology or mental disorders are the hardest in diagnosis and treatment as they lies in an abstract area [20]. According to Suhasini et al. [21] psychological distress and disabilities are increasingly identified among general population. On analyzing recent development, it becomes clear that the trend is to develop new method for decision making using computer in psychiatry and to evaluate these methods in practice [21].

Despite significant advances in software and hardware technology over the past decades, effective clinical expert systems are still largely an unrealized dream in the medical field [22]. Early medical expert systems such as MYCIN [23] generated optimism, but following systems like INTERNIST-I and CADUCEUS have been failures despite over a decade of development [22][24]. However, small scale medical DSS's, which are in use, have contributed notable improvements in the quality of health care delivery [25][26].

A number of medical expert systems or CDSS's have been developed to address problems in health care, but there are only few clinical decision support systems for psychiatry problems [14][21]. Some recent research articles aim to provide CDSS in the fields of psychology and psychiatry (e.g. [21][27][28][30][31].

A Brazilian university group of psychiatrists have developed a CDSS for diagnosing schizophrenia [27]. Their SADDESQ system is a tool for the students to diagnose psychotic disorders. The knowledge for the CDSS was extracted from experts through interviews. The interviews explored the expert's diagnostic decision-making process for the diagnosis of schizophrenia. A graph methodology was used to identify the elements involved in the reasoning process.

Suhasini et al. [21] proposed a method to identify the psychiatric problems among patients using multimodel decision support system. Backpropagation neural networks, radial basis function neural network and support vector machine models was used to design the DSS. 44 factors were considered for feature extraction. The features was collected from 400 patients and divided into four sets of equal size. Experimental results show that their CDSS achieved an accuracy of 98.75% for identifying the psychiatric problems. [21]

Trivedi et al. [28] presented a CDSS for the treatment of major depressive disorder using evidence based guidelines. They have transferred the knowledge gained from the Texas medication algorithm project. CompTMAP, which was developed at the University of Texas Southwestern Medical Center, is a CDSS for the treatment of depression and some other psychiatric illnesses. Introduced CDSS provides support in diagnosis treatment follow up and preventive care. Later the barriers of implementation of the CDSS system for depression were studied in real clinical settings [29]. The clinicians and support staff was concerned about lack of time and the impact of the program on clinical workflow. The clinical support system was merged with an existing electronic health record in a public mental health care system and it became a routine part of the system of care.

Rollman et al. [32] examined the results of an electronic medical record system in a primary care setting that provided electronic feedback to physicians in the diagnosis of depression found that some primary care physicians do agree with the diagnosis provided by the CDSS feedback and used it to base their decisions to start therapy.

Yong et al. [14] introduced DECES, an interactive self-help online expert system, developed to diagnose patients' depressive conditions and provide recommendations to decrease their levels of depressions. The DECES captures expertise knowledge and make it available to sufferers, who are not seeking or procrastinate in getting help, to do self-assessing and obtain advice. Decision flowchart was used to represent expertise knowledge and further extracted into rules as the knowledge base for the system. A comparison of the system's diagnosis using real cases with psychologists' diagnosis on similar cases revealed a high degree of correspondence.

Harmonex group have a DSS for the use of mental health settings. The Harmonex neuroscience research division deals for example with depression, schizophrenia, bipolar disorders, ADHD, anxiety. Their CliniCom DSS uses electronic medical records. CliniCom is a computer assisted intake and assessment tool designed for use in mental health settings. It generates clinical reports by gathering information directly from patients, parents, and/or guardians prior to an initial evaluation. CliniComt provides doctors with an unprecedented level of information regarding their patients' condition. (www.harmonex.us)

4. ADHD diagnostics challenges at Eksote

In November 2010, Eksote established a new acute emergency walk-in clinic/ward where referrals are not needed for the adult mental and substance abuse patients. Clinic is open from 8:30 am to 20:30 pm weekly. In the nights and weekends patients are evaluated by the emergency department of the mental health hospital, which is located in the same building and nearby the somatic emergency facilities.

In the new clinic the mental health and addiction care professionals were not segregated, as it has been tradition, between mental health and addiction patients, but they build up an integrated mental and addiction care system. Since the opening of the clinic the professionals face new and earlier untreated patient groups, and adult ADHD patients were one of them. The clinic did not have anything to offer to adult ADHD patients. The neuropsychiatric clinic of the university hospital is 250 kilometres away and they do not have possibilities to evaluate all adult ADHD-patients in the Eksote area. According to the prevalence rates (4-5 %) the Eksote area has 5000-6000 adult ADHD patients. Most of them are undiagnosed. They are surely met in various facilities which are established for helping people with functional impairments (for example unemployment agencies, social security system, addiction treatment facilities and mental health services).

The emergency open clinic met many new untreated adult patients, who have possibly ADHD. The clinic did not have any procedures for adult ADHD-patient diagnosis or treatment, and faced the problem of diagnosing adult ADHD-patients, who have almost always many comorbid psychiatric disorders. The clinic has also a need to make the diagnoses more accurate and to establish efficient assessing and treating processes in unselected populations, who came to the new emergency department.

To overcome these problems the mental health and addiction care professionals of the emergency clinic started to develop a computer-assisted diagnostic process which includes the whole complex ADHD-diagnosis procedure. The clinic needed to establish a program for adult ADHD patients, and thus a evaluation, diagnosis and treatment process by a multi-professional team was developed. The multi-professional evaluation group includes a psychiatrist, four psychologists, an ADHD nurse, an addiction nurse, a social worker and an occupational therapist. Each of the team members developed his/her expertise sheet, which includes all the important themes for assessing and diagnosing adult ADHD-patients and patients' functional impairments. The multi-professional evaluation was launched with support by a tailor-made CDSS provided by a consulting company, ROCE Partners. The CDSS supports the implementation of the new adult ADHD patient evaluation, diagnosis and treatment process. The CDSS guaranteed that the multi-professional team has from the start an algorithmic and extensive work-up of adult ADHD patients. Appendix 1 clarifies the common contents of the extensive work-up. The CDSS also warranted that Eksote has established standards for the care of adult ADHD patients. The CDSS enables the possibility to make quick changes in the process and to develop the work-up for adult ADHD patients on a continuous basis.

5. Adult ADHD diagnostics solution

5.1. New process design and supporting computer solution

In order to overcome the challenges in the ADHD diagnostics process, Eksote decided to utilize an agile BPM approach to develop a new computer-based solution for the process. The development platform used was Serena Business Manager (www.serena.com/products/sbm/) which was chosen based on earlier experiments in other process areas. Eksote co-operated with an external partner, ROCE Partners (www.roce.com) in process and solution development.

The objectives set for the new process and solution were the following:

- Effective workflow management: During the ADHD diagnostics process, the patient will be examined and diagnosed by multiple persons. In order to have an efficient process in place, the status of each patient in the process must be known in real time. Furthermore, the process and the solution must guide all participating persons of the mental health care staff by showing each person the tasks they have to complete.
- Process standardization: The new process and solution must unify the diagnostics process by including the jointly agreed diagnostics approaches and tools, question templates and logic. Thus, in addition to workflow management features, the new solution includes elements of an expert system which is used for standardizing the diagnostics approach and performance within the Eksote mental health care unit. The new solution provides the tool for educating new members of the staff about the Eksote way of working.

5.2. Phases of the development project

The development project was executed by following the principles of agile business process development. The project team consisted of six persons representing the different parties involved in the ADHD diagnostics process. One external consultant was included in the project team, and he was in charge of leading the development work.

The development project was divided into four main phases:

- Process definition: The first phase of the project was to agree on the new process definition for the ADHD diagnostics process. The objectives of this phase were to analyze the current way of working, to identify the development areas and to agree on the new, common process design which was the basis for the solution development phase. In addition to the definition of the process steps, an important aspect of this phase was to define the common diagnostics tools to be used in the different parts of the process. The process definition phase lasted about two weeks and the main tasks included interviews of the various stakeholders in the process and workshops for the project team.
- Solution development: Using the process design as the basis, an initial version of the new computer-based solution was created by the external consultant within a week. An important feature in the development process was iteration of the solution design in quick cycles. The project team had frequent meetings were they went through the existing version of the solution and defined the needed changes and adjustments. The external consultant created new versions of the solution between the project team meetings. Normally, the interval between the project team meetings was two weeks. The iterative approach was very effective as the project team was involved intensively in the actual solution development process: the project team was able to steer and control the solution development by giving their comments and seeing almost instantly the impact of their change requests.
- User acceptance testing and training: The user acceptance testing phase was started after the project team felt satisfied with the solution. The objective of this phase was to test the usability of the developed solution with a wider user group and to identify potential errors. The testing phase lasted two months and it resulted to quite many changes in the solution. For example, the process workflow was slightly changed, more diagnostics tools were added and some features were finetuned.
- User training and implementation: The fourth phase of the project was user training and implementation of the solution. The user training was organized as a joint session for all users but individual support was also given afterwards when needed. The actual implementation of the solution was a straightforward task as the solution had been finetuned and tested extensively in the earlier phases of the project. This proved to be one of the strengths of the iterative development approach as there were no negative surprises concerning the functionalities of the solution in the implementation phase.

5.3. Process workflow

The outcome of the first main phase of the development project (process definition) was the new ADHD diagnostics process workflow (Figure 1). The new workflow is based on the needs and requirements

of Eksote and it consists of seven main phases. The main phases are the following:

1. Enter a new patient: The first step in the process workflow is to enter the details of a new patient into the ADHD diagnostics solution. The information entered at this stage includes the personal details of a person but also an evaluation of the new patient's situation by a social worker.
2. Organize the preparatory diagnostic meeting: The second main step in the process is to organize a preparatory diagnostic meeting where the information of each new patient is reviewed and the decision concerning the need for various psychiatric examinations is made. The participants of the preparatory meeting are the members of the ADHD team: the psychiatrist, the ADHD nurse, the social worker and the psychologist. The outcome of the meeting is a task list for each meeting participant which shows which examinations they have to carry out for each patient.
3. Carry out the examinations: During the third step of the process workflow, the members of the ADHD team carry out the defined examinations for each patient. The examinations are carried out by using the diagnostic tools built into the ADHD solution. The results of the examinations are recorded in the ADHD solution giving thus visibility to the progress of the process.
4. Organize the final diagnostic meeting: The fourth step of the process is the final diagnostic meeting where the decisions concerning the further treatment or rehabilitation of each patient are made. The final meeting is organized only when all defined examinations for each patient have been carried out. The developed ADHD solution shows which patients are ready for the final meeting thus eliminating the danger of having meetings organized in vain.
5. Place the patient to rehabilitation: Based on the decision of the final diagnostic meeting, the patient is placed to rehabilitation. The duration of the rehabilitation period is individually defined.
6. Evaluate the patient's condition: The condition of the patient is diagnosed on a regular basis while he/she is in the rehabilitation. The ADHD solution is used for carrying out the examinations and for comparing the results to the earlier ones. Depending on the progression in the patient's condition, decisions are made concerning the rehabilitation and the methods for further treatment.
7. Place the patient to the decided rehabilitation or treatment: The final step of the process is to place the patient to the decided long term treatment or rehabilitation.

5.4. The diagnostics tools included in the solution

As discussed above, there are multiple different actors involved in the process. The diagnostics tools used by these actors have been built into the ADHD process solution as an integrated part. Thus, when the members of the ADHD team carry out the examination of a patient, they choose the needed diagnostic tool in the solution menu and fill in the form that opens.

The main diagnostics tools are the following:

- social worker: Designed functioning level questionnaire, SOFAS, AUDIT
- ADHD nurse: ASRS 1.1 and DIVA 2.0
- psychologist: DIVA 2.0, WAIS-III, WMS-III and a wide range of specific neuropsychological assessment tools (the results of these methods are modified for the solution)
- addiction nurse: addiction evaluation and SDS, part of EuropASI and PRISM
- psychiatrist: BPRS, MADRS, MDQ, YMRS, PROD and broadened SCID
- occupational therapist: AMPS, MOHOST, OSA and HOME assessment.

The diagnostics tools provide the actors in the process with a standardized, easy-to-use approach to evaluating the condition of a patient. Most of the questions in the tools have a drop-down list of alternative choices for answers. Furthermore, deductive logic has been built in where possible meaning that the ADHD process solution proposes a conclusion based on the information entered. The built-in deductive logic is based on both generally used and ADHD-specific psychiatric rating scales and diagnostic criteria.

The created solution automatically composes a summary of the results of all diagnostics tools thus providing a complete overview of the analyses

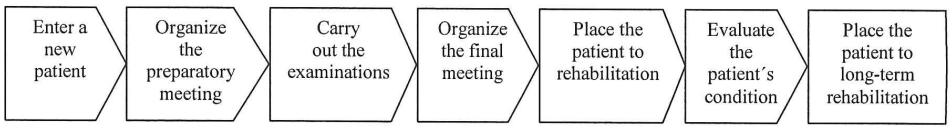

Figure 1. Adult ADHD diagnostics process workflow

conducted on a patient. Creating the summary is a straightforward task as all diagnostic tools are an integral part of the ADHD solution. Thus, no interfaces with other systems are required. The summary shows the consensus view of the ADHD team on the condition of each patient as the potential differences of opinion have been addressed in the joint final diagnostic meeting with regard to each patient.

The diagnostics process confirms if a patient is suffering from adult ADHD or not and establishes the basis for making the decisions concerning treatment solutions and rehabilitation options. These decisions are recorded in the ADHD solution, and thus the solution can be used for following up the chosen treatment paths.

5.5. Experiences of the developed ADHD solution

The developed ADHD diagnostics solution has been in use at Eksote since early 2012. The solution is a Clinical Decision Support System that combines a process workflow management system with a decision support system. The usage and experiences are being followed up on a continuous basis in regular meetings of the Eksote mental health care management team and the group of main users. Based on the experiences so far, the following main benefits have been identified:

- The workflow management features of the solution have improved the efficiency of the organization as all actors have now clearly defined task lists with due dates and status notifications. There is total transparency about the status of the tasks in the organization and thus the joint meetings are only organized when all participants are ready for them. Before the new solution was taken into use, unnecessary and inadequately prepared meetings where a significant source of inefficiency in the organization.
- The multiple diagnostics tools in the developed solution standardize the way patients are analyzed at Eksote. Standardized tools ensure that all actors in the ADHD diagnostics process utilize the same approaches and fulfil the defined performance standards. Furthermore, the standardized tools provide an effective training tool for new members in the Eksote team.
- The solution can be developed and changed flexibly. Based on user experiences, new ideas and requirements for the development of the tool have been identified. The agile development approach and the agile features of the used software platform allow for making changes to the solution in a quick manner.
- The developed solution includes comprehensive reporting possibilities. For example, the process lead times can be measured to identify bottlenecks and the results of the individual diagnostics tools can be cross-referenced to identify correlations. All information and changes including the time of editing and the actor doing the editing can be accessed and reported. Reporting provides the Eksote personnel with possibilities to develop the process and the ADHD solution further. Furthermore, profession-specific reports can easily be generated to satisfy the needs of each member of the ADHD team.

The main source of dissatisfaction among the users has been that the included diagnostics tools are quite extensive and thus time consuming to fill in. However, the management at Eksote have made a conscious decision to utilize these tools to set the standards for diagnosis approach. If the current tools prove to be too

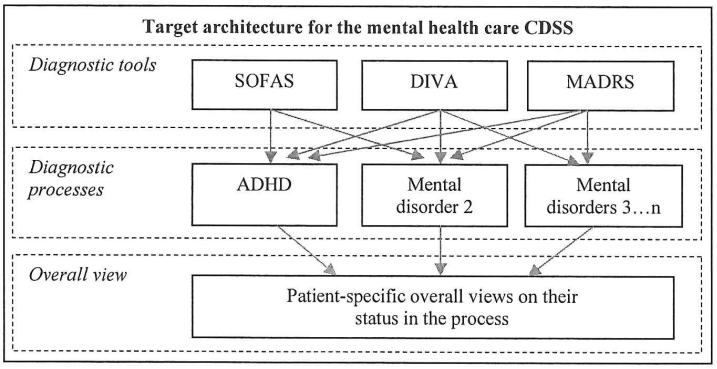

Figure 2. The target architecture for the mental health care CDSS

laborious to use, they can be easily modified or removed.

6. Conclusions

Due to the multiple challenges identified in the adult ADHD diagnosis process at Eksote, an agile business process development approach was applied to create a Clinical Decision Support System for it. The developed CDSS combines a workflow management tool with a decision support system. The solution has improved the efficiency of the process, standardized the use of diagnosis tools in the organization and given total transparency to the process with extensive reporting possibilities.

The adult ADHD evaluation and diagnostic procedure has enabled a real dialogue about adult ADHD patients care between various mental health and addiction care professionals, because each adult ADHD team member has been obliged to add something concrete and central from own professional specialized evaluation and diagnosing tool, which is valuable for the whole process of adult ADHD patient care.

The experiences from the actual usage of the adult ADHD diagnostics solution have been encouraging and thus the next steps in development have already been started. The main focus in further development is to extract the individual diagnostics tools from the adult ADHD solution into individual modules. These modules can then be utilized in other diagnosis processes as well. This will improve the efficiency of the diagnosis processes further as the results of an individual diagnosis tool can be utilized across multiple processes. The overall target (Figure 2) for the development is to create a comprehensive CDSS that includes all diagnosis tools, can be applied to all major mental disorders and gives the possibility to plan and manage the rehabilitation phase for each patient.

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APPENDIX: THE EXTENSIVE WORK-UP INCLUDES

Team	Tools / tasks
Social worker	- Designed functioning level questionnaire of social situation, based on interview - SOFAS (Social and Occupational Functioning Assessment Scale) assessing social, occupational and relationship functioning in the last year (current, past and best in ongoing year); is an overall functioning scale - AUDIT (Alcohol Use Disorders Identification Test), describes how to use it to identify persons with hazardous and harmful patterns of alcohol consumption. The AUDIT was developed by the World Health Organization (WHO) as a simple method of screening for excessive drinking and to assist in brief assessment. It can help in identifying excessive drinking as the cause of the presenting illness. It also provides a framework for intervention to help hazardous and harmful drinkers reduce or cease alcohol consumption and thereby avoid the harmful consequences of their drinking.
ADHD-nurse	- ASRS v1.1 (A- and B-parts), WHO Adult ADHD Self-Report Scale (ASRS) Symptom Checklist. A-part is self-report questionnaire, B-part is evaluation part, which ADHD nurse is filling - DIVA (Diagnostic Interview for ADHD in adults) 2.0 Summary A and H/I about symptoms, based on interview of the relatives of adult ADHD patients - interviews concerning childhood and adulthood, teacher interview, life style interview
Psychologist	- DIVA (Diagnostic Interview for ADHD in adults) 2.0 Summary A and H/I about symptoms, based on interview of adult ADHD patients - WAIS-III (Wechsler Adult Intelligence Scale - III) for assessment current intellectual functioning - WMS -III (Wechler Memory Scale -III) for assessment of overall memory skills - a wide range of standardised neuropsychological test batteries for assessing specific cognitive strengths and weaknesses: language, speech and communication skills, attention, concentration and executive functioning, reading and writing skills
Addiction nurse	- Urine specimen, screening for drugs - SDS (The Severity of Dependence Scale); provides a short, easily administered scale which can be used to measure the degree of dependence experienced by users of different types of drugs. The SDS contains five items, all of which are explicitly concerned with psychological components of dependence. These items are specifically concerned with impaired control over drug taking and with preoccupation and anxieties about drug use. - EuropASI (European Addiction Severity Index), only the part screening drugs - nurses part of PRISM (Psychiatric Research Interview for Substance and Mental Disorders): the PRISM is a semi-structured clinician-administered interview that measures DSM-III, DSM-III-R, and DSM-IV diagnoses (current and past) of alcohol, drug, and psychiatric disorders and continuous measures of severity, organic, etiology, treatment, and functional impairment
Occupational therapist	- AMPS, The AMPS is comprised of 16 ADL motor skill items and 20 ADL process skill items that the occupational therapist scores across two ADL tasks (72 items in total). As a result, the AMPS is a highly sensitive measure of ADL performance - MOHOST (The model of Human Occupational Screening Tool), addresses client´s motivation for occupation, pattern of occupation, communication, process and motor skills and environment - OSA (Occupational Self Assessment), is designed to capture client´s perception of their own occupational competence on their occupational adaptation - Home Assessment, the role of assessing the home environment from the person´s perspective is critical to person´s daily routines and self esteem
Psychiatrist	- BPRS (The Brief Psychiatric Rating Scale) is rating scale which a clinician or researcher may use to measure psychiatric symptoms such as depression, anxiety, hallucinations and unusual behaviour. Each symptom is rated 1-7 and depending on the version between a total of 18-24 symptoms are scored - MADRS (The Montgomery–Åsberg Depression Rating Scale) is a ten-item diagnostic questionnaire which psychiatrists use to measure the severity of depressive episodes in patients with mood disorders. - MDQ (The Mood Disorder Questionnaire), screening instrument for bipolar spectrum disorder, developed by Robert Hirschfeld - YMRS (Young Mania Rating Scale); a rating scale used to evaluate manic symptoms at baseline and over time in individuals with mania. The scale has 11 items and is based on the patient's subjective report of his or her clinical condition over the previous 48 hours. - PROD-screening; for prodromal symptoms of psychosis, PROD-screen consists of 29 questions assessing performance and symptoms - Applied and lengthened broadened SCID (Structured Clinical Interview for DSM-IV Axis I Disorders); to facilitate writing psychiatric reports for various purposes (for example to social security authorities, police, courtroom and employment authorities)

Publication II

Kemppinen, J., Korpela, J., Elfvengren, K., Salmisaari, T. and Polkko, J.
Decision Support in Evaluating the Impacts of Mental Disorders on Work Ability

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Decision support in evaluating the impacts of mental disorders on work ability

Juha Kemppinen
Eksote, Valto Käkelän katu 3,
FI-53100 Lappeenranta, Finland
juha.kemppinen@eksote.fi

Jukka Korpela
Chainalytics,
Tekniikantie 14, FI-02150
Espoo,
Finland jkorpela@chainalytics.com

Kalle Elfvengren
Lappeenranta University of
Technology, Skinnarilankatu 34,
FI-53850 Lappeenranta,
Finland kalle.elfvengren@lut.fi

Timo Salmisaari
Eksote
timo.salmisaari@eksote.fi

Jussi Polkko
Chainalytics
jpolkko@chainalytics.com

Abstract

Assessing work ability involves considering symptoms of mental disorders relevant to work activity. This paper introduces a systematic process workflow and a Clinical Decision Support System (CDSS) for the evaluation of the impacts of mental disorders on work ability. The introduced CDSS is currently in use in the South Karelia District of Social and Health Services (Eksote) in Finland. By using the CDSS, Eksote has standardized the work ability evaluation process and has ensured effective execution of the process within the organization.

1. Introduction

The objective of this paper is to introduce a systematic process for evaluating the work ability of mental health care patients and to present a Clinical Decision Support System (CDSS) that enables the implementation of the process in practice. The developed CDSS provides the users with workflow management of the diagnostics process, tools for supporting the diagnostic examinations and a tool for managing patient-specific information across various diagnostics processes.

Evaluation of the work ability of mental disorder patients is an essential part of the evaluation, treatment and rehabilitation of mental disorders. Psychiatric guidelines to the valuation of the impacts of mental disorders on work ability are sparse and inconclusive. Critics across Europe have pointed out the lack of quality and transparency of disability evaluation [1]. The financial impacts of work disability caused by mental disorders are significant, and thus it is essential to have a systematic process for evaluating the work ability of a person and to be able to determine the best treatment to restore and maintain it.

The CDSS introduced in this paper is currently in use in the South Karelia District of Social and Health Services (Eksote) in Finland. Eksote arranges secondary health care, primary health care, and care for the elderly, as well as social welfare services for its eight member municipalities. Eksote delivers patient-oriented care to approximately 130 000 citizens of South Karelia. It employs approximately 4 100 people and has a budget of 370 million euros. Eksote operates in a geographical area of over 5 600 square kilometers.

2. Impact of mental disorders on work ability

Epidemiologic research in community and clinical settings reveals a strong correlation between mental disorders and impaired occupational and social functioning. Primary care patients with depressive and anxiety disorders have poorer social, role, and occupational functioning than patients without these disorders. Depressive disorders have also been associated with a larger number of disability days and poorer role functioning than several common general medical diseases, including arthritis, hypertension, and diabetes. The link between specific mental disorders and functional disability may be obscured by the co-occurrence of multiple mental disorders within the same individual. [2]

Health systems will need to address the needs of the rising numbers of individuals with a range of disorders that largely cause disability but not mortality. Effective and affordable strategies to deal with this rising burden are an urgent priority for health systems in most parts of the world [3]. It is estimated that by 2030, depressive disorders will be the leading illness

causing years of full health lost in the high-income countries [4].

There is not any definitive evidence that the incidence and prevalence of mental disorders is rising in Finland. However, almost 40% of disability pensions are granted due to a major depressive disorder. The share of major depressive disorders has doubled in ten years, and the use of anti-depressive medication has increased by 500% at the same time. [5]

3. Evaluation of the work ability of mental health patients

Based on an extensive literature review, evaluation of the work ability of mental health care patients has not been a widely researched area. Thus, no definitive rules can be found in the psychiatric literature about how to conduct a proper work ability evaluation process for a mental health patient. There are no common descriptive definitions in psychiatric textbooks [6][7] or psychiatric literature of how work disability or "a clinically significant disturbance" is manifested in different psychiatric diseases.

Disability refers to the past, present, and future outcome of a person's interaction with his/her physical, social, cultural and legislative environment [1]. Work disability and impairment need to be defined on the basis of how the patient functioned before the onset of the signs and symptoms with which he/she is presented for evaluation [8].

Mental health care professionals must establish a causal relation between a patient´s health condition and his/her functional and dysfunctional capacity as required by social insurance laws and social insurance physicians.

The work ability evaluation of a mental health patient is a joint, complex and challenging task to mental health professionals. The work ability evaluation is based on the patient's work and health history, objective findings in clinical examination and the relation of the findings to work ability and overall capacity in functioning (for example ICF, WAI, OFS, WHODAS 2.0) in the society. These are difficult to align because of the contradictory interests of the parties involved.

The Work Ability Index (WAI) has been used in occupational health literature in order to measure the work ability of even people with common mental health [9][10][11], but in our experience it is not applicable to our decision support in evaluating work ability in common mental disorders.

The Occupational Functioning Scale (OFS) has been suggested for evaluating the work ability of psychiatric patients, but OFS has not been used widely in psychiatric work ability evaluations. [12]

The new DSM-5 [13] proposes to use WHODAS 2.0 (World Health Organization Disability Assessment Schedule 2.0) as a disability assessment tool instead of GAF (Global Assessment of Functioning) in the earlier version of the DSM [14].

In our experience GAF [15] is better than WHODAS 2.0, which is too indistinctive to psychiatric work ability evaluation. GAF is intended to assess the severity of psychiatric disorders, and severity is not always in direct relation to the work ability of a person with a psychiatric disorder.

In our experience the evaluation of the work ability and disability of mental health patients must deal with the following issues [16]:

1) Are there medical diseases which explain the decline in work and functional capacity?
2) Are the diseases treated properly and according to evidenced-based guidelines?
3) Is there enough work and functional capacity for the work which the mental disorder patient is already doing and if not, are there any possibilities to make changes in the working conditions in order to facilitate continuation of work despite the decline in work and functional capacity?
4) Would working or a sick leave support recovering from mental health disorders?
5) What is the remaining work and functional capacity and how can it be strengthened?
6) Which are the conditions of rehabilitation and to what extent is the recovering mental health patient able and willing to commit to rehabilitation of his/her mental disorders?

In order to answer these issues, the evaluation of the work ability of mental health patients at Eksote consists of clinical evaluations by a psychiatrist, a psychologist, psychiatric and addiction nurses, a social worker, and an occupational therapist. If the evaluation of a patient cannot be conducted in an open ward, the patient can be placed in a day-care unit or an inpatient facility of the mental health hospital at Eksote.

The work ability evaluation process confirms whether the patient is suffering from a psychiatric disorder or not and establishes the basis for making the decisions concerning the work ability of the patient, sickness certification, and treatment and rehabilitation options.

4. Psychiatric CDSS literature review

A clinical decision-support system (CDSS) is any computer system designed to help healthcare workers

to make clinical decisions. In a sense, any computer system that deals with clinical data or knowledge is intended to provide decision support. Information-management tools (as health-care information systems and information-retrieval systems) provide the data and knowledge needed by the clinician, but they generally do not help in applying that information to a particular decision task. Interpretation is left to the clinician, as is the decision about what information is needed to resolve the clinical problem [17]. CDSS is software that supports clinical decision-making, in which the characteristics of an individual patient are matched to a computerized clinical knowledge base, and patient-specific assessments or recommendations are then presented to the clinician and/or the patient for a decision [18].

CDSSs fall generally into two categories: those that assist healthcare workers with determining what the correct diagnosis is, and those that assist with decisions about what to do for the patient (usually what test to order, whether to treat, or what therapy plan to use) [17]. Many systems assist healthcare workers with both activities.

The advantages of CDSS include automation of the diagnosis process and objective measurements and observations of selected parameters. CDSS provides support to the decision-making process, but it does not make any actual decisions; the role of the clinical expert is fundamental in the decision making [19].

All clinical decisions are complex, but compared to other aspects of health care, psychological or mental disorders are the hardest for diagnosis and treatment as they lie in an abstract area [20]. Psychological distress and disabilities are increasingly identified among the general population [21]. When analyzing recent development, it becomes clear that the trend is to develop new methods for decision making using a computer in psychiatry and to evaluate these methods in practice [21][22].

A number of CDSSs have been developed to address problems in health care, but there are only a few clinical decision support systems for psychiatrical problems [21]. Some research articles aim at providing CDSS in the fields of psychology and psychiatry (e.g. [21][23][24]).

A Brazilian university group of psychiatrists have developed a CDSS for diagnosing schizophrenia [23]. Their SADDESQ system is a tool for students to diagnose psychotic disorders. The knowledge for the CDSS was received from experts through interviews. The interviews explored the experts' diagnostic decision-making process for the diagnosis of schizophrenia.

Suhasini et al. [21] propose a method for identifying the psychiatric problems of patients using multimodel DSS. Backpropagation neural networks, radial basis function neural network and support vector machine models were used to design the DSS. The experimental results showed that their CDSS achieved good results in identifying the psychiatric problems.

Trivedi et al. [24] present a CDSS for the treatment of a major depressive disorder using evidence-based guidelines. The introduced CDSS provides support in diagnosis, treatment follow-up and preventive care. Later the barriers of implementation of the CDSS system for depression were studied in real clinical settings [25]. The CDSS was merged with an existing electronic health record in a public mental health care system and it became a routine part of the system of care.

5. Challenges in the work ability evaluation process at Eksote

About 130 mental health patients have been evaluated since the work ability evaluation team was established at Eksote in November 2010. However, it has become evident that the evaluation process and the supporting tools must be improved in order to overcome the challenges the evaluation team is facing.

The first major challenge at Eksote is that the referral process to work ability evaluation is fragmented and random. The primary care physicians take care of the short-term disability associated with psychiatric disorders, and thus many psychiatric disorders are inadequately treated in primary care. The referral policy has been changed and written referrals are no longer needed. Nurses and psychologists have been arranged to work together with primary care physicians and nurses to treat mental health patients more effectively. A quick consultation by a psychiatrist is always available to primary care personnel when needed. A short message from a primary care physician is enough to begin the work ability evaluation of a mental health patient. Also an online questionnaire about mental health disorders has been developed to help align the work ability evaluation process within the organization.

The second major challenge is that the physicians are too sparse and vague in describing the anamnesis, status and functional (dis)ability, diagnostic criteria and treatment of mental disorder patients. The work history of a patient is not always adequately analyzed, and the symptoms of mental disorders relevant to work activity are not always considered thoroughly enough when assessing the work ability. Comorbid psychiatric diagnoses are usually missing. An extensive and systematic examination process must be implemented

in order to ensure that all mental health disorders are covered in work evaluation.

The third major challenge is the selection of the right treatment path for a patient. Undertreated mental health patients need to be steered and maintained adequately in effective treatment following evidence-based guidelines. A common reason for rejecting a medical report for pension is inadequate treatment options tried in mental disorders. The work ability evaluation process must guarantee that the best possible treatment is offered to the mental health patient.

The fourth major challenge is organizing a systematic follow-up procedure for treatment. The treatment and rehabilitation of a mental health patient need to be launched as soon as possible in order to avoid unnecessary delays. Up-to-date information is needed about the locations where the patient is receiving treatment, and about the level of the progress of the patient.

The final major challenge is that the different phases of treatment and rehabilitation of mental health patients need to occur without interface problems between different treatment and rehabilitation providers. Eksote must be able to change the treatment and rehabilitation options for a patient between providers flexibly while ensuring that all the necessary patient-specific information is transferred to the new provider. Process information must be available to all participants easily in order to avoid delays in the work ability evaluation process because of missing information.

Due to the multiple challenges found in the work ability evaluation process, the decision makers at Eksote have realized that a concise support system is needed to make the work ability evaluation process more efficient and effective.

6. Process solution for work ability evaluation

6.1. Overall CDSS architecture at Eksote

Eksote has utilized an agile business process management BPM process approach to the development of CDSS in the area of mental health care since 2011. The development platform is called Serena Business Manager (www.serena.com/products/sbm), which was chosen after it had been tested in other parts of the organization. The objectives Eksote wanted to achieve through the new approach were the following: (1) effective workflow management in order to ensure that all necessary steps in the processes are taken in a timely manner, and (2) process standardization in order to unify the diagnostics processes by enforcing the use of jointly agreed diagnostic tools, question templates and logic. The first CDSS implemented in mental health care in Eksote was the process solution to support the ADHD diagnostics process [26].

Based on the positive experiences gained from the ADHD diagnostics process solution, Eksote decided to create a comprehensive CDSS architecture (Figure 1) that includes all the diagnostics tools in use, combines individual process solutions for all major mental disorders, and enables planning and management of the rehabilitation phase for each patient. Mental health care patients have often more than one disorder, and thus the decision makers at Eksote decided that it is of utmost importance to maintain an overall view on each patient, i.e. in which diagnostic processes a person is included and which diagnostic tools have been applied to the person.

The overall CDSS architecture consists of three layers:

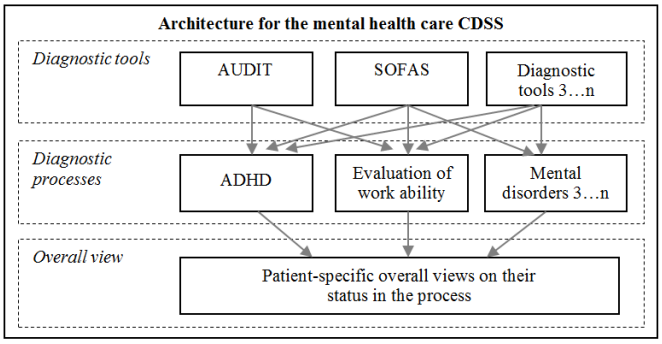

Figure 1. Overall CDSS architecture for mental health care

1) The layer “diagnostic tools” includes all individual diagnostics tools that are currently in use at Eksote. The reason for creating a separate layer for the diagnostic tools is that the tools are not necessarily specifically used for only one mental disorder. As the diagnostic tools are included in the CDSS as individual modules, they can be used across the various diagnostic processes in an effective way.
2) The layer “diagnostic processes” consists of the process solutions for the various mental disorders. The process solutions are used for managing the process workflows and for combining the right set of diagnostic tools for each mental disorder. The process workflows guide the users through the needed process steps in a strict manner. However, the users must always decide specifically which diagnostic tools are to be used for each patient. The process solution for the evaluation of work ability was the second major diagnostic process that was added to this layer.
3) The layer “overall view” provides the users with a tool for patient management and enables overall coordination across different processes and domains. By entering a patient´s name and/or social security number the users can see what diagnostic tools have been applied to the patient, which diagnostics processes the person has been involved in and what rehabilitation plans have been defined for the patient and how the plans are being executed. The overall view on the patient removes the former problem that a person was included in multiple diagnostic processes and the same diagnostic tools were applied within a short timeframe. The overall view gives a person-centric view on the processes and tools, showing all relevant information across all diagnostic processes. Laws and regulations permitting, the information can be shared easily with different organizational domains in order to avoid overlapping diagnostics processes.

Due to the layer-based structure, the developed CDSS can be expanded to cover all diagnostic processes used at Eksote. When a new diagnostic process workflow is added to the corresponding layer, all existing diagnostic tools are available and new specific tools can be added to the diagnostics tools – layer if needed. The new diagnostic processes and tools are then connected to the overall view –layer to enable a holistic view on the patient.

6.2. CDSS process workflow for the evaluation of work ability

The members of the work ability evaluation team have defined the process workflow according to the needs and requirements of Eksote (Figure 2). The development project covering both the process and the CDSS was carried out by following the principles of agile business process development. A detailed discussion on the phases of the development project can be found in [26].

One of the main objectives of Eksote is process standardization, and thus the main steps in work ability evaluation are closely related to those of the ADHD solution [26], although the actors and the actual content of the process steps are different. The new workflow consists of six main phases:

1) Enter a new patient: The first step in the process workflow is to enter the details of a new patient into the process solution of work ability evaluation. The information entered at this stage includes the personal details of a person, as well as an evaluation of the new patient’s initial situation by a social worker.
2) Decide the approach: The second main step in the process is to organize a preparatory diagnostic meeting where the initial situation of each new patient is reviewed and the decision concerning the need for various diagnostics tools is made. The participants of the preparatory meeting are the members of the work ability evaluation team: a psychiatrist, a psychologist, psychiatric and addiction nurses, a social worker and an occupational therapist. The outcome of the meeting is a task list for each team member showing which diagnostics they have to carry out for each patient.
3) Carry out the diagnostics: During the third step of the process workflow, the members of the work ability evaluation team carry out the defined examinations for each patient. The examinations are carried out by using the diagnostic tools available in the Eksote mental health care CDSS

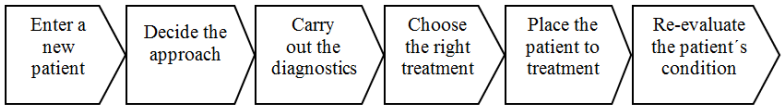

Figure 2. The process workflow for work ability evaluation

architecture. The results of the examinations are recorded, thus giving visibility to the progress of the process.

4) Choose the right treatment: The fourth step of the process is the final diagnostic meeting where the decisions concerning the further treatment or rehabilitation of each patient are made. The final meeting is organized only when all defined examinations for each patient have been carried out. The process solution of work ability evaluation shows which patients are ready for the final meeting, thus eliminating the danger of having meetings organized in vain.
5) Place the patient to treatment: Based on the decision of the final diagnostic meeting, the patient is placed to further treatment. The type and duration of the treatment period is defined for each patient individually.
6) Re-evaluate the patient's condition: The condition of the patient is diagnosed on a regular basis while he/she is in treatment. The developed process solution is used for carrying out the examinations and for comparing the results to the earlier ones. Depending on the progress in the patient´s condition, decisions are made concerning rehabilitation and methods for further treatment.

6.3. The diagnostic tools and outcome of the evaluation

There are six different actors and roles in the work ability evaluation process. All these actors use various diagnostic tools to support their evaluation of a patient´s condition. These diagnostic tools are all included in the "diagnostics tools" layer of the CDSS for mental health care. None of the diagnostics tools existed in a computerized, automated form earlier, and all of them were separately programmed into the CDSS.

The main diagnostics tools used by the evaluation team in the work ability evaluation process solution are the following:

- Social worker: a specifically designed questionnaire to evaluate the level of work ability and functional abilities, SOFAS, AUDIT
- Psychiatric nurse: screening of mental disorders through an online questionnaire of previous and actual psychiatric symptoms, MDI, MADRS, MDQ, YMRS, when needed various screens of anxiety, somatoform and eating disorders, PROD, mini-PANSS and SCID II
- Psychologist: WAIS-III-IV, WMS-III and a wide range of specific neuropsychological assessment tools (the results of these methods are modified for the solution), structured clinical interview and observation, personality inventories and projective test methods
- Addiction nurse: screening and evaluation of addiction problems and SDS, part of EuropASI and part of PRISM
- Psychiatrist: BPRS, MADRS, MDQ, YMRS, PROD and modified broadened SCID I
- Occupational therapist: AMPS, MOHOST, OSA and HOME assessment.

One of the benefits of the layer-based structure of the CDSS developed at Eksote is that some of the diagnostic tools used for work ability evaluation are the same as the ones used in the ADHD diagnostics process [26]. Thus there was no need to re-create these tools specifically for the work ability evaluation process, but it was enough to add only the needed new diagnostics tools. All the diagnostics tools follow the same basic design rules: (1) they provide the actors in the work ability evaluation process with a standardized, easy-to-use approach to the evaluation of the work and functional capacity of mental disorder patients, (2) when feasible, the questions included in the tools have a drop-down list of alternative choices for answers and (3) deductive logic has been built in where possible, meaning that the work ability process solution proposes a conclusion based on the entered information. The built-in deductive logic is based on both generally used and specific psychiatric rating scales and diagnostics criteria.

The CDSS provides the work ability evaluation team with a patient-specific summary of the results of the applied diagnostics tools. These results then form the basis for the final joint diagnostic meeting where the evaluation team makes the decision concerning the right treatment for each person. The plans for the chosen treatments are then recorded into the CDSS in order to enable monitoring and follow-up of the progress the patient makes.

In the Eksote work ability evaluation process, the patients and potential treatments for the patients are classified into four generic groups. The Eksote work ability evaluation team has defined the groups during the CDSS development project based on the work of Vuokko [16] and their own practical experience. The defined groups are the following:

1) Patients who need some extra capacities in order to have or maintain their working ability. They usually have not finished their formal education because of lack in certain abilities which are required in formal education. Common findings are specific learning and communicational difficulties, below than normal IQ and behavioral problems.

2) Patients who are recovering from an actual mental illness and are trying to return to their working places. They usually have residual symptoms of a mental disorder and are undertreated in their mental illness. When recovering from a mental illness and returning to work, they initially need to work part time in order to get their working routines back without relapsing again. They can be on a part time sick leave before returning to full-time work.
3) Dropouts from working life, to whom tailored extensive mental health and occupational rehabilitation efforts should be established in order to restore their work and functional ability. Many aligned psychosocial facilities need to cooperate in the rehabilitation because of multifactorial causes of work and functional disability.
4) Patients who are to be pensioned, who have not recovered from mental disorders in spite of exhaustive treatment and rehabilitation options, and whose work and functional incapacity is permanent. Efforts to preserve their all-day life functional capacities are taken in daycare facilities.

6.4. Experiences of the developed CDSS

The first CDSS in mental health care that Eksote took into use was the ADHD diagnostics solution in early 2012. Based on the first months of utilizing the ADHD solution, the decision makers at Eksote realized that the solution developed for the ADHD process would benefit other diagnostics processes as well. Furthermore, there were clear similarities between the various diagnostics processes in terms of the process workflows and diagnostics tools used. An essential observation by the Eksote decision makers was that mental health care patients often suffer from more than one mental disorder, and thus the management of patient information across various diagnostics processes was needed.

The learning and experiences from the ADHD diagnostics solution led to the development of a comprehensive CDSS architecture for mental health care. Due to its economical significance, the process for evaluating work ability was added as the second diagnostic process to the overall CDSS. Overall, the CDSS has enabled Eksote to achieve the two main objectives it had set for mental health care processes: (1) effective workflow management and (2) standardization of the tools and approaches used within a certain diagnostics process.

The developed CDSS has proven to be an effective tool for meeting the challenges Eksote is facing in mental health care. Specifically, the developed CDSS has enabled Eksote to overcome the main challenges in the work ability evaluation process that were outlined in section 5. The referral process is now managed more effectively, as all new patients are entered into the CDSS on the basis of the evaluation of the initial situation. The CDSS enforces the evaluation team to utilize a chosen set of diagnostic tools and evaluations, thus ensuring an extensive diagnosis. The results of the thorough diagnosis enable the evaluation team to choose the right treatment path for each patient. Furthermore, the CDSS supports follow-up of the progress the patient is making in the chosen treatment. Finally, the CDSS enables flexible exchange of information between the various actors and organizations involved in the overall work ability evaluation process.

Due to the three-layered architecture, the CDSS can be modified and expanded easily. The diagnostic process –layer currently includes the ADHD and work ability evaluation processes, but actions are already taken to add new processes, e.g. the process for preventing societal alienation of young persons. The overall view –layer helps to reduce the risk for overlapping diagnostic examinations across the various processes and enables Eksote mental health care personnel to create and maintain comprehensive rehabilitation plans for each patient.

One challenge with the developed CDSS is that the extensive diagnostics tools are quite time-consuming to fill in, and thus there has been some dissatisfaction among the users. The dissatisfaction is understandable, as earlier there were no established standards on which diagnostic tools were to be used and how the results were to be recorded. The developed CDSS enforces process discipline and establishes a standardized approach to all aspects of the diagnostics processes.

A major development action needed is creating a wider integration with the patient health record system. Import of the referrals and basic information of patients from the patient health record system to the CDSS and export of the outcome of the diagnostic tools and the decisions concerning treatment from the developed CDSS to the patient health record system are to be automated. Integration with the patient health record system will increase the effectiveness of the developed CDSS, as many time-consuming manual data entry steps will be eliminated.

7. Conclusions

Early detection of impairment of work capacity, evaluation of functional capacity by a multi-professional team, and appropriate timing of treatment and rehabilitation for mental health patients are the main factors helping to prevent mental disorders and marginalization of mental health patients, which diminish the quality of their life and cause costs for the

society. Evaluation of the work ability of mental health patients is a complex process where Eksote has faced many difficult challenges. In order to improve the process, an agile business process development approach was applied to create a Clinical Decision Support system for it. The developed CDSS combines a workflow management tool with a decision support system. The solution has organized the fragmented and obscure process, aligned evaluation, treatment and rehabilitation efforts and given new incentives to develop joint efforts for the work ability evaluation of mental health patients.

Well-known risk factors for work disability are the duration and severity of prior episodes of sick leave due to mental disorders, as well as the type and severity of the disorder [27]. Our evaluation results show that acute substance abuse and alcohol problems must be treated before the evaluation process. Another issue to remember is that the evaluation of the work ability of mental health patients and the efforts to return to work should be started as soon as possible in order to avoid long-term disability.

The developed CDSS covers two diagnostic processes at the moment: the ADHD process [26] and the evaluation of work ability. The CDSS has enabled Eksote to execute these processes more efficiently and effectively, and thus the CDSS will be expanded to include the processes for preventing the social alienation of young persons, for evaluating the need for opiate dependency treatment and for policlinic ECT-treatment of adults. The three-layered architecture of the developed CDSS provides a platform where new diagnostic processes and diagnostic tools can be added flexibly.

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Publication III

Kemppinen, J., Korpela, J., Elfvengren, K. and Polkko, J.
Clinical Decision Support System for Opioid Substitution Therapy

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Clinical Decision Support System for Opioid Substitution Therapy

Juha Kemppinen
Eksote
Lappeenranta, Finland
juha.kemppinen@eksote.fi

Jukka Korpela
Chainalytics
Espoo, Finland
jkorpela@chainalytics.com

Kalle Elfvengren
Lappeenranta University of Technology
Lappeenranta, Finland
kalle.elfvengren@lut.fi

Jussi Polkko
Chainalytics
Espoo, Finland
jpolkko@chainalytics.com

Abstract

Opioid addiction is a chronic relapsing disorder affecting millions of people worldwide and having significant social and health impacts. Opioid substitution therapy has turned out to be one of the most effective treatments for opioid addiction. This paper introduces a Clinical Decision Support System (CDSS) for opioid substitution therapy. Opioid-dependent patients are one of the most resource-demanding patient groups in addiction care in Finland. The CDSS is needed in order to achieve an effective and efficient treatment process for opioid substitution therapy. The developed CDSS has proven to be an effective tool in the case organization. The improvements have increased productivity and ensured the quality of the diagnostics processes. A major factor in productivity improvement is that the developed CDSS keeps track on the tasks that the persons involved in the process have to perform. Furthermore, the CDSS enables effective management of patient flow, as the status of each patient in the process is fully visible.

1. Introduction

The objective of this paper is to introduce a Clinical Decision Support System (CDSS) for the opioid substitution therapy (OST) process. The CDSS has been developed in the South Karelia District of Social and Health Services (Eksote) in Finland. Eksote arranges secondary health care, primary health care, and care for the elderly, as well as social welfare services for its eight member municipalities. Eksote delivers patient-oriented care to approximately 130 000 citizens in South Karelia. It employs approximately 4100 people and has a budget of 500 million US dollars.

Opioids are considered the most harmful of all illicit drugs. Illicit opioids result in a lot of mortality and morbidity. Opioids are intertwined with enormous social and economic costs. In developed countries, this has been repeatedly estimated at close to 0.4 % of the GDP [1]. Opioid substitution therapy as a flexible-dose methadone maintenance treatment (MMT) is more clinically effective and cost-effective than any other drug therapy for dependent opiate users [2]. Opioid-dependent patients are the most resource-demanding patient group per patient in integrated mental health and addiction care at Eksote. The Clinical Decision Support System is needed in order to achieve an effective and efficient treatment process of opioid substitution therapy.

The developed CDSS is a part of the overall CDSS architecture in the Eksote mental health care services unit. The CDSS for the opioid substitution therapy process complements the process layer which already includes specific CDSS solutions for the ADHD (attention deficit hyperactivity disorder) process, the work ability evaluation process, the rehabilitation planning process, and the patient placement process. The main objectives Eksote has set for the CDSS solutions are effective workflow management and standardization of tools, as well as the approaches used within and across the various diagnostic processes. Furthermore, the overall management of the patient flow is one of the focus areas.

2. Opioid substitution therapy process

2.1 Background

The term ‘opioids’ refers to a class of psychoactive substances derived from the poppy plant (including opium, morphine and codeine), as well as semi-synthetic forms (including heroin) and synthetic compounds (including methadone and buprenorphine) with similar properties. [3]

Opioid addiction is a drug addiction which has two prominent features: recurrent failure to control the use of one or more opioids, and continuation of opioid(s) use despite significant harmful consequences. Opioid use disorder is diagnosed mild, if a person has two or

three of eleven symptoms (forming opioid use disorder syndrome) in 12 months. Moderate if four to five symptoms exist and severe if six or more symptoms are prevailing in 12 months. [4]

Opioid addiction is a chronic relapsing disorder that has significant social and health consequences, including high level of unemployment, criminal activity, reliance on health and social services, blood-borne infections, and high prevalence of concurrent other addictions and psychiatric disorders. Opioid substitution treatment is a treatment of chronic opioid-dependent individuals. There is much evidence for the effectiveness of opioid substitution therapy to various problems in opioid addiction [5][6][7][8][9]. Substitution maintenance therapy is one of the most effective treatment options for opioid dependence. It can decrease the high cost of opioid dependence for individuals, their families and the society at large by reducing heroin use, associated deaths, HIV risk behaviors, and criminal activity [9].

Opioid substitution therapy can be maintained with methadone, buprenorphine, levacetylmethadol (LAAM) and slow-release oral morphine (SROM). LAAM was withdrawn from the EU market in 2001 as life-threatening ventricular rhythm disorders had been reported by the European Monitoring Centre for Drugs and Drugs Addiction [10]. SROM is only available in a few European countries (Austria, Bulgaria, and Slovenia). SROM has shown similar intravenous abuse as buprenorphine, and in December 2012, Sweden withheld buprenorphine (Subutex) from the market because of its problematic intravenous abuse. In Finland buprenorphine-naloxone (Suboxone) is the most common form of opioid substitution medicine with the share of 58 %, followed by methadone, 38 % [9].

EMCDDA [10] estimates that the current prevalence of adult problem opioid use in Europe is at 0.41 %, which means 1.4 million problematic opioid users. About 50 % of them, i.e. 730 000 patients, receive opioid maintenance treatment. The lowest number of opioid users in opioid maintenance therapy has Latvia (3 %), and the highest Norway (70 %). The highest rate of problem opioid use is in Ireland at seven cases per 1 000 of the adult population.

There were 1.2 persons per 1 000 inhabitants aged 15–64 (range: 1.06 to 1.04), and about 4 204 problem opioid users (range: 3 700 to 4 900) in Finland in 2005, according to the latest estimates of high-risk drug use populations the capture-recapture method [10][11]. On the basis of the estimates from 2005, about 1 300 problematic opioid users lived in the Eksote area in South Karelia in south-east Finland.

Addiction experts (e.g. Thomas D. Crothers, William L. White) have tried over a hundred years to convince professionals and lay people that opiate addiction is primarily a physical disease, which should be treated by medication. Opioid addiction has been defined as a chronic, relapsing disorder [5][12][13]. Neurobiological studies in reward pathways (from the ventral tegmental area (VTA) of the brainstem via nucleus accumbens of the limbic area to the frontal cortex) have shown that dysfunction of the normal reward pathways is a neurobiological explanation of addiction [14][15][16]. Dopaminergic reward pathways in the mesocorticolimbic system play a major role in drug-reward, which is associated with the development of substance dependence, and the dopamine 3-receptor (DRD3) may account for more susceptibility to heroin and opioid addiction [17]. Critics of the (neuro) biological theory of addiction argue that people take drugs because they want to and because it makes sense for them to do so given the choices available, rather than because they are compelled to by the pharmacology of the drugs they take [18][19].

The vivid history of the medical therapy of opioid-dependent patients is full of fierce struggles for and against the legitimate use of opioid medication in treatment [20][21]. Discussion for and against medical treatment of opioid dependency has been going on since the American Civil War (1861-1865) because the hypodermic syringe was invented at that time. Syringes facilitated a faster and more direct route by veins to brain, which accelerated and worsened opioid addiction. 100 years ago, 1914 The Harrison Anti-Narcotic Act (federal system for the regulation of drug manufacturers, pharmacies, and physicians prescribing) shifted the attitudes from treatment of a suffering patient to punishment of a manipulating villain. This national decision closed the existing 44 morphine clinics in the US. The responsibility for the addiction problem was shifted to the criminal justice system. The controversies of treating opioid dependency with opioid medication still confuse the working atmosphere of health and addiction professionals [22].

Today, the most common view of addiction is that opioid addiction is a treatable chronic condition comparable to other chronic conditions, such as hypertension and asthma. ”Drug addiction is seen as a chronically relapsing disorder that is characterized by (1) compulsion to seek and take the drug, (2) loss of control in limiting intake, and (3) emergence of a negative emotional state (e.g., dysphoria, anxiety, irritability) reflecting a motivational withdrawal syndrome when access to the drug is prevented” [23]. Recent general theory of addiction states that drug addiction is a real psychiatric disease caused by a three-step interaction between vulnerable individuals and amount/duration of drug exposure [24].

The too mechanistic theory of the biological origin of addiction was broadened by the biopsychosocial model in psychology [25] in order to account better for the realities of opioid-dependent patients. The biopsychosocial model is "suggested with great promise as a viable and much needed alternative to the prevailing "medical model" in which problems and disorders were considered akin to medical diseases and ailments" [26]. The definition of addiction is still elusive [22], which confuses the operationalization of the treatment of opioid use disorder patients [4].

The biopsychosocial model of opioid dependency, and the legislation based on that model declare that the opioid substitution treatment should consist, in addition to the opioid medicine, of psychosocial consultations and interventions. Psychosocial consultations and interventions have been shown to improve the effectiveness of opioid patient treatment [7][27]. The legislation-based demand of psychosocial consultation has become a barrier to the availability of opioid substitution treatment. A Canadian study [28] suggests a different model, Low-Threshold/High-Tolerance Methadone Maintenance Treatment (LTHT MMT), which challenges the traditional comprehensive methadone maintenance program. The study states that "the majority of financial resources are invested in those ancillary psychosocial services that support the biopsychosocial model, whereas the LTHT approach utilizes a medical model and directs resources at medical management."

The effectiveness of opioid substitution treatment refers to a reduction of mortality and morbidity, and reduction or cessation of opioid and other drugs use. The effectiveness refers also to reduced HIV and viral hepatitis risk behaviors, especially needle use, reduced HIV and viral hepatitis transmission rates, as well as decrease in criminal involvement and redundancy [29].

Contrary to other chronic conditions, e.g. hypertension and asthma, opioid-dependent patients have in addition somatic problems [30], and problems in almost every area of life, which makes the treatment of opioid-dependent patients a challenging enterprise. Opioid treatment experts must deal daily with many-sided problems of the chaotic life of the opioid-dependent patient. The standardized process of opioid substitution treatment can relieve the unnecessary stress and pressures of the employees of integrated mental health and addiction care in their daily work duties.

Opioid substitution therapy consists of different phases: 1) evaluation of the chronic opioid-dependence phase and suitability for opioid substitution therapy (1-3 months, outpatient phase), 2) induction and stabilization phase of opioid substitution therapy (3-6 months, inpatient and outpatient phase), 3) adherence and motivational phase of opioid substitution therapy (3-6 months, outpatient phase, sometimes inpatient phase), 4) early psychosocial rehabilitation phase (6-9 months, outpatient phase), 5) psychosocial rehabilitation phase (9-18 months, outpatient phase), 6) referral to other treatment phase (18-24 months, outpatient phase), and 7) cessation or maintenance phase of the opioid substitution phase (6-24 months, outpatient phase). [31]

In opioid substitution therapy the first two or three years are typically defined as the rehabilitation phase and after three years OST is defined as the maintenance phase. The rehabilitation and maintenance phases have different emphasis and goals, the rehabilitation phase is more active and the goals are focused more on returning the normal functioning of every-day life. The maintenance phase directs to living with a chronic disorder and prevailing the functioning level of this day.

2.2 The process at Eksote

The redesigning of mental health and addiction care services at Eksote [32], and the treatment of opioid-dependent and other drug addiction patients were shifted from an addiction clinic to a newly established non-referral, 24/7/365 open walk-in clinics (MTPA, integrated mental health and addiction care clinic). At the same time, substitution medication was changed from buprenorphine-naloxone to methadone because of process efficiency.

The main goals of the process of opioid substitution treatment in Finland are to examine whether the opioid-dependent patient is qualified to the opioid substitution treatment according to the Finnish law considering delivering opioid substitution therapy (http://www.finlex.fi/en/).

The evaluation process of an opioid-dependent patient at Eksote is to guarantee that the patient has tried other treatment options, for example withdrawal treatments. All information of patient health recordings is gathered by permission from the patient. The evaluated patient is interviewed by an addiction nurse, a social worker and a physician. The relatives of the patient are met when it is possible regarding the circumstances. During the evaluation period, the patients are screened and advised to reduce and abolish consumption of other addictive substances. The rules of opioid substitution therapy are introduced to the patient.

The first aim in the induction of the opioid substitution treatment, which is started in the inpatient ward, is to stabilize the opioid-dependent patients´ physical condition. The other drugs, usually benzodiazepines, are reduced and abolished. Dual-

diagnosis patients, who have other psychiatric diseases, are prescribed medications they really need. The rules of OST are rehearsed. At Eksote the opioid substitution medicine is methadone, because it is the cheapest and fastest available form of an opioid substitution drug (seven times cheaper than buprenorphine-naloxone, and methadone is delivered and patient health recordings filled out in 15 minutes; buprenorphine-naloxone takes easily 30 minutes to give). Methadone is the easiest one to perform as an efficient process (diversion problems with liquid methadone are limited to take-home dosages that are obtained after six month's treatment).

Psychosocial consultation of an individual employee (a care manager) are included as a necessary part of a holistic view of treating patients' overall health issues and treating drug-related diseases. The personal care manager deals with everyday worries and issues which are not handled at the same time when delivering the daily methadone dose. The recovering opioid-dependent patient has many issues to be solved: health, housing, financing and other urgent issues.

Opioid-dependent patients have usually many psychiatric disorders, for example major depression and several personality disorders, which set strict requirements to qualifications of the employees of OST. The employee must have a working knowledge of psychiatric and addiction conditions.

The purpose of the consultation of occupational therapists and psychologists is to integrate the patient in social and work life. The stabilized and recovering patient is evaluated by his qualifications to start studying, working or rehabilitating his professional career in the working life. Very few of chronic opioid patients have higher education, they have usually dropped out of school in their teens.

The ultimate goal is to free the patient from opioid dependence, which is hardly ever achieved with a chronic opioid-dependent patient. The opioid substitution therapy process has to be planned in a many years perspective, often a lifetime perspective. These goals are negotiated in the treatment meetings, which are held weekly, and when needed at once at the beginning of the OST. Meetings about when the OST patient is stabilized and recovered are held once a month or once in three months. The meetings are held with the patient, the personal care manager, a physician and an addiction nurse. When needed, an occupational therapist and psychologist are invited to the treatment meetings as well.

Opioid substitute patients have so far not been transferred to the pharmacy delivering mode or to the rehabilitation department of integrated mental and addiction care of Eksote.

2.3 Challenges at Eksote

The newly established facility personnel (in November 2010) in the integrated mental health and addiction care clinic (MTPA) faced almost new opioid-dependent patients with buprenorphine-naloxone opioid substitution therapy. The evaluation and induction of opioid substitution treatment of the opioid-dependent patients were done in Kouvola (a city 62 miles from Lappeenranta) or in the social hospital of Järvenpää (124 miles from Lappeenranta). Over a half (over 130 000 US dollars per year) of the annual outsourcing budget for the habilitation of alcohol and substance abuse patients went to these activities. These resources were not for developing the local expertise in the treatment of chronic opioid dependent patients. The joint treatment meetings (mainly issues of the beginning of OST) were held in those distant places, which meant that the whole working day could be spent in treating one patient.

The delivering nurses solved daily opioid medication delivery problems and solutions (intoxication, which meant losing the daily dose, or other issues denying daily doses), which was personalized to the delivering nurses. The physician responsible for the treatment visited the addiction clinic twice a week (three hours per day). The treatment team met twice a week to settle issues of OST, among others insulting or aggressive behavior or other issues regarding the treatment. The patients did not get direct sanctions for their improper behavior and had even forgotten the incident altogether.

The experienced but not qualified competent physician could not improve the opioid substitution process. It was almost impossible to get the consultation of psychologists, occupational therapists or psychiatrists and other specialized personnel in the fragmented and polarized care between mental health and addiction care. Most chronic opioid dependent patients are dual or triple diagnosis patients, who fall between the functional citadels of fragmented care.

The attitude towards treating criminally stigmatized and behaviorally delicate opioid-dependent patients was punitive and abandoning. The patients did not seek for treatment, and when they did, it was mainly at the somatic emergency department, where they were met by somatically focused workers. "Alcohol and other drug dependence can be chronic diseases, but they are usually treated episodically. Few seek treatment, and most who do, do not complete it" [33]. To overcome the barriers to opioid substitution treatment and to achieve a value chain of an opioid-dependent treatment process, it was decided at Eksote to launch a CDSS-facilitated process.

3. Previous research on CDSS for OST

Decision support systems (DSS) are computer technology solutions that can be used to support complex decision-making and problem-solving. One subcategory of DSS is Expert Systems. An expert system is a computer system that emulates the decision-making ability of a human expert [34]. Among the many fields in which Expert System is involved, medicine holds a large domain [35]. There are specialized expert systems used as decision support for different areas in medicine, and these systems are also known by the general term Clinical Decision Support Systems (CDSS). Clinical Decision Support Systems are "active knowledge systems which use two or more items of patient data to generate case-specific advice" [36]. According to Sim et al. [37] CDSS is software that is designed to be a direct aid to clinical decision-making, in which the characteristics of an individual patient are matched to a computerized clinical knowledge base, and patient-specific assessments or recommendations are then presented to the clinician and/or the patient for a decision. The advantages of CDSS include automation of the diagnosis process and objective measurements and observations of selected parameters. CDSSs provide support to the decision-making process, but they do not make any actual decisions; the role of the clinical expert is fundamental in the decision making [38].

Information and communication technology can provide the right health information, to the right person, at the right place, on time and in a secure electronic format. However, developing effective CDSSs for the highly complex and dynamic domain of clinical medicine is a serious challenge for designers, and e.g. poor usability is one of the main barriers to the adoption of these systems [39]. According to Horsky et al. [39], developers need to adopt design practices that include user-centered, iterative design and common standards based on human–computer interaction research methods rooted in ethnography and cognitive science.

A recent study by Nicholas et al. [40] explores how pharmaceutical opioid misuse could be reduced by the implementation of a technological tool. Their paper explores how enhancement to existing clinical decision support systems through real-time, on-line information to prescribers, pharmacists and regulators could address drug-seeking and improve the quality use of medicines. According to Nicholas et al. [40] there is a lack of access to comprehensive information about patients' medication use, which can contribute to medicines being prescribed inappropriately or in excess of therapeutic need. The poor-quality use of medicines can involve inappropriate prescribing, prescribing errors, adverse drug events, and intentional misuse.

Electronic health record systems play an increasingly important role in opioid dependency treatment, e.g. [41][42]. According to Ghitza and Tai [41], meaningful use of electronic health record system -based tools could help health care professionals in developing appropriate holistic treatment plans based on patients' complete medical histories, taking into account medications and other treatments furnished by other providers. According to Serpelloni et al. [42], there are electronic health record systems to capture data describing the patient population and treatment outcomes. These systems have been used to obtain information on the types and prevalence of the drugs used, to identify emerging problems, determine the effectiveness of treatment services, plan for treatment services to meet the needs of the patients, and to support evidence-based decision making [42].

Xiao et al. [43] outline the rationale for designing an electronic healthcare record with extensibility, interoperability and decision support functionality. According to Xiao et al. [44], the their aim was to establish a system which facilitates easy data entry and decision support for general practices, as well as easy data collection and auditing for clinical authorities. They implemented a web-based data entry system and a decision support function for the system. The continuous treatment on methadone was incrementally recorded in the episodes of care. Being supplied with the knowledge of the past treatment history, as well as the current condition of the patient, a decision support system can be designed and integrated into the electronic healthcare record, which makes sense of the record and guides the current consultation [44][45].

4. CDSS for the opioid substitution therapy process

4.1 Overall CDSS architecture at Eksote

Eksote has utilized an agile business process management (BPM) process approach to the development of CDSS in the area of mental health care since 2011. The development platform is called Serena Business Manager (www.serena.com/products/sbm), which was chosen after it had been tested in other parts of the organization. The targets Eksote wanted to achieve through the new approach were the following: 1) effective workflow management in order to ensure that all necessary steps in the processes are taken in a timely manner, and 2) process standardization in order to unify the diagnostics processes by enforcing the use of jointly agreed diagnostic tools, question templates

and logic. The first CDSS implemented in mental health care at Eksote was a process solution to support the ADHD diagnostics process [46]. The overall CDSS architecture was first presented by Kemppinen et al. [32], and afterwards the description of the architecture has been expanded further [47].

Based on the positive experiences gained from the ADHD diagnostics process solution, Eksote decided to create a comprehensive CDSS architecture (Figure 1) that includes all the diagnostics tools (e.g. SOFA - Social and Occupational Functioning Assessment Scale) in use, combines individual process solutions for all major mental disorders, and enables planning and management of the rehabilitation phase for each patient. Mental health care patients have often more than one disorder, and thus the decision makers at Eksote decided that it is of utmost importance to maintain an overall view on each patient, i.e. in which diagnostic processes a person is included and which diagnostic tools have been applied to the person.

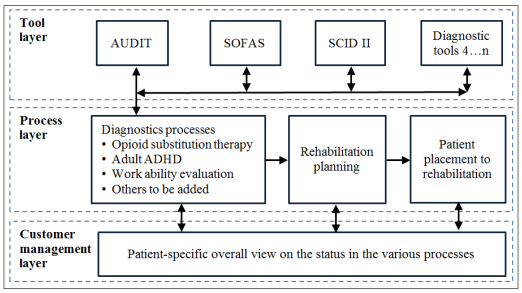

Figure 1. Architecture of the mental health care CDSS

The overall CDSS architecture consists of three layers:

1) The tool layer includes all individual diagnostics tools that are currently in use at Eksote. The reason for creating a separate layer for the diagnostic tools is that the tools are not necessarily specifically used for only one mental disorder. As the diagnostic tools are included in the CDSS as individual modules, they can be used across the various diagnostic processes in an effective way.

2) The process layer consists of the process solutions for diagnostics, rehabilitation planning and patient placement. The diagnostics process solutions are used for managing the process workflows and for combining the right set of diagnostic tools for each mental disorder. The process workflows guide the users through the needed process steps in a strict manner. However, the users must always decide specifically which diagnostic tools are to be used for each patient. Currently there are three diagnostics processes in use: ADHD, work ability evaluation and opioid substitution therapy. New diagnostics processes can be added easily to the architecture.

The process solution for rehabilitation planning provides a structured way for deciding on the needed further actions on the basis of the findings in the diagnostics processes. A comprehensive plan is defined for each patient, and this plan is used as the basis for the patient placement process solution. The objective of the patient placement solution is to ensure that each patient will get further treatment in a facility that matches the requirements defined in the rehabilitation plan. The patient placement solution supports the decision makers in managing and balancing the demand (patients) and the supply (available rehabilitation places in various facilities).

3) The customer management layer provides the users with a tool for patient management and enables overall coordination across different processes and domains. By entering a patient´s name and/or social security number the users can see what diagnostic tools have been applied to the patient, which diagnostics processes the person has been involved in, what rehabilitation plans have been defined for the patient, how the plans are being executed, and where the patient has been placed for further treatment. The overall view on the patient removes the earlier problem that a person was included in multiple diagnostic processes and the same diagnostic tools were applied within a short timeframe. The overall view gives a patient-centric view on the processes and tools, showing all relevant information across all diagnostic processes. Laws and regulations permitting, the information can be shared easily with different organizational domains in order to avoid overlapping diagnostics processes.

Due to the layer-based structure, the developed CDSS can be expanded to cover all the diagnostic processes used at Eksote. When a new diagnostic process workflow is added to the process layer, all existing diagnostic tools are available, and new specific tools can be added to the tool layer if needed. The new diagnostic processes and tools are then connected to the customer management layer to enable a holistic view on the patient.

4.2 CDSS workflow for the OST process

The first step in the development of the CDSS for the opioid substitution therapy process was to define the process workflow. The mental health care unit had already experience in defining the processes for the CDSS for the ADHD process [46] and the work ability evaluation process [48]. An agile business process development approach was used in order to ensure that the process and the CDSS matched the users'

requirements as closely as possible. The phases of an agile business process development approach have been presented in detail in Kemppinen et al. [47].

The process workflow for opioid substitution therapy consists of six steps (Figure 2):

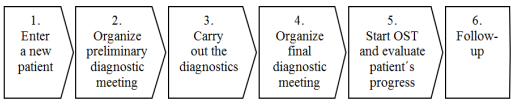

Figure 2. The CDSS process workflow

1) Enter a new patient: The addiction nurse responsible for the OST patients enters a new patient into the CDSS. The nurse enters the patient´s information by using a standardized template included in the CDSS. The nurse also conducts the first evaluation concerning the patient´s qualification for opioid substitution therapy.

2) Organize a preparatory diagnostic meeting: If the addiction nurse has evaluated a patient to be potentially qualified for opioid substitution therapy, the nurse organizes a preparatory diagnostic meeting. The participants of this meeting always include the addiction nurse, the doctor in charge of OST and a social worker. When needed, an occupational therapist and a psychologist participate in the meeting. The objective of the preparatory meeting is to create mutual understanding on the patient´s initial situation and to decide who should carry out more detailed diagnostics on the patient. The outcome of the meeting is a task list recorded in the CDSS.

3) Carry out the diagnostics: Diagnosis by a doctor and a social worker are always required, while a psychologist and an occupational therapist will provide their input based on the decisions in the preliminary meeting. The CDSS includes templates to be used for various diagnostics, like for example AUDIT, MADRS, MDQ, SDS, SCID I and SCID II. Furthermore, standardized templates have been created for the input of the social worker and the occupational therapist. Basically, all diagnostics tools included in the tools layer in the overall mental health care CDSS structure can be utilized in the OST process as well.

4) Organize the final diagnostic meeting: The CDSS keeps track of the progress of the various diagnostics tasks assigned in the preparatory meeting. Once all the persons involved in the process have carried out their tasks, the addiction nurse summons a final diagnostic meeting. The objective of this meeting is to utilize the outcome of the various diagnostics tasks to decide if the patient is qualified for entering opioid substitution therapy. The participants of the final diagnostic meeting always include the addiction nurse, the doctor and the social worker. If needed, the occupational therapist and the psychologist also participate in the meeting.

5) Start OST and evaluate the patient´s progress: If accepted for opioid substitution therapy, the patient is placed in a ward for methadone treatment for a period of six weeks on average. During the treatment, the condition and the progress of the patient is monitored constantly. Both the doctor and the nurses in charge follow up the situation on a daily basis and record their findings into the CDSS. The CDSS supports the follow-up process by providing the doctor and the nurses with diagnostics tools, like CIWA-B (screening tests for alcohol and benzodiazepine withdrawal symptoms) and SOWS (screening test for opioid withdrawal symptoms). The opioid substitution therapy is carried out as long as needed to get the patient into a physical and mental condition where treatment in a ward is no longer necessary.

6) Follow-up: After release from opioid substitution therapy in a ward, the patient is still subject to systematic follow-up in order to ensure that the achieved improvement in the patient´s condition is sustained. The CDSS supports this phase by providing the tools for follow-up diagnostics and for recording the outcome of the follow-up procedure. Furthermore, the patient can be entered into new processes, like the ADHD process or work ability evaluation process if the follow-up diagnostics give any indication for such needs.

Overall, the process steps in the opioid substitution therapy process are close to the ones in the ADHD and work ability evaluation processes. Having a similar basic logic across the processes is beneficial for the organization as same users are involved in multiple processes. However, there are some features that differentiate the OST process from the ADHD and work ability evaluation process. Firstly, the number of actors in the OST process is defined more patient-specifically than in the other processes, and there is more variation in the type and number of the diagnostics tools used. Secondly, a specific feature of the OST process is that it includes an observation period in the ward, during which diagnostics tools are used on the patient very extensively. Compared to the other processes, the OST process necessitates a daily follow-up of the patient´s condition and progress and thus provides a lot of data to support decision-making. The observation period and the daily utilization of the diagnostics tools is continued as long as needed.

4.3 Features and benefits of the CDSS for the opioid substitution therapy process

The opioid substitution therapy process is the third diagnostics process in the Eksote mental health care

services unit for which a CDSS has been developed. The main justification for the continuous extension of CDSS utilization is that the developed support systems have enabled Eksote to achieve two main improvements in their mental health care operations [47]: 1) effective workflow management and 2) standardization of the process steps and diagnostics tools used within and across the diagnostics processes.

These improvements have enabled Eksote to increase productivity in mental health care services and to ensure the quality of the diagnostics processes. A major factor in productivity improvement is that the developed CDSS keeps track on the tasks that the persons involved in the process have to perform. Furthermore, the CDSS enables effective management of patient flow, as the status of each patient in the process is fully visible. In the past, there was no transparency to how the responsible persons actually carried out the diagnostics, as everybody could decide themselves which diagnostics tools and approaches to use. The results were not recorded comprehensively, and thus e.g. extensive analyses across all patients were not possible. With the new CDSS, all persons involved in the process have to use the ready-made diagnostics tools that can be found in the system. The results are recorded in the common database, allowing full utilization of the diagnostics data.

One major benefit of the developed CDSS is that it provides an overall view on a patient. As stated above, the patients included in the opioid substitution therapy process often suffer from other mental health care problems. As the CDSS system for the opioid substitution therapy is part of the overall CDSS architecture in Eksote mental health care services, the customer management layer can be utilized to track the status of the patient in the other processes, like for example the ADHD process and work ability evaluation process. Furthermore, the CDSS shows if a certain diagnostics tool has been recently applied to a patient in any process within the overall CDSS architecture, and thus overlapping work can be avoided.

The agile development approach and the IT platform utilized in the development of the CDSS for the opioid substitution therapy process and in the development of the overall CDSS architecture for Eksote mental health care services allow flexible and quick modification and further development of the solutions. The time needed for the development of the first version of the opioid substitution therapy process CDSS was about three weeks. The objective was to have the CDSS in the actual use of practitioners as quickly as possible in order to fine-tune the CDSS based on actual user experiences. The proposals for development are being systematically collected, and corresponding changes and modifications are made on the CDSS. Typically, the requested changes are small and require a few hours of work to have them incorporated in the CDSS.

As with the CDSS solutions for the ADHD process and the work ability evaluation process, there are two main challenges with the CDSS for the opioid substitution therapy process. Firstly, some of the practitioners are dissatisfied with the need to use the diagnostics tools included in the CDSS. This is due to the fact that they can no longer choose whether to use a certain tool or not, as they are required to apply the chosen tools in order to take the process forward. However, the practitioners seem to understand the need for standardizing the diagnostics processes, and thus the dissatisfaction has not become a major hurdle for the use of the CDSS. Secondly, there is a need to create a two-way integration with the patient health record system. Planning for the import of the basic information of the patients to the CDSS and the export of the outcome of the opioid substitution therapy CDSS has been started and the actual implementation of the integration is expected to take place within a year. This is an important step to be taken, as currently the practitioners have to enter the outcome of the CDSS into the patient health record system manually.

5. Experiences and further development

The clinical decision support system of opioid substitution therapy visualized the whole process of OST. A shared vision of OST helped to maintain “the big picture” in rehabilitating chronic opioid-dependent patients. The big picture of treatment is easy to lose because of the daily claims from these patients. Resolving the everyday issues of these patients is prone to the phenomenon of “not seeing the forest from the trees”. The phase of OST in which the patient is, helps both the patient and the employee to concentrate on the issues decided in the treatment meetings. The goals of the different phases of OST are easy to reiterate or develop further in the process of OST in the agile CDSS.

The CDSS of OST facilitates following the phase of the opioid substitution therapy and focusing on the goals of that phase, instead of going back and forth with the ample wishes of patients. Personality disorders are over-presented in these clients. Typically, the behavior of patients with personality disorders confuses and disturbs the treating team. The manipulating style of these patients results easily in conflicts between the members of the treating team.

Opioid substitution therapy is the most resource-consuming process in mental health and addiction care. Every visit or other resources saved by the CDSS is a

huge asset in resource allocation. The Pareto principle 20/80 applies to these patients, 20 % of the patients consume 80 % of the resources. OST is a cost-effective form of treatment [10], but it consumes a lot of resources per patient. Resource savings can be achieved by the CDSS of OST, which makes it possible to perform more efficiently, as the waste of the process can be analyzed by the CDSS. The bottlenecks, errors and scrap of OST process can be diminished iterating CDSS of OST.

The double recording of patient information is time-consuming and real waste in the OST process. The ordinary patient health recordings (Effica) and the CDSS of the Serena-based platform have neither open access face-offs nor a navigation possibility between the software.

The need for entering patient information in both the CDSS and the patient health record system is time-consuming and a real waste in the OST process. While the developed CDSS has open interfaces based on the utilization of the standard "web services" interfaces, programming the required interfaces in the patient health record system is an expensive and time-consuming exercise. However, steps towards a better integration between these two systems are being taken.

The overall architecture of the CDSS of Eksote is evolving, and the graphic quality of the layout of the CDSS needs to be elaborated by a graphic designer in order to make it more user-friendly and aesthetic.

6. Conclusions

Opioid addiction is a chronic relapsing disorder affecting millions of people worldwide and having significant social and health impacts on the society. Opioid substitution therapy has turned out to be one of the most effective treatments for opioid addiction. However, the OST is a complex and long-lasting process with multiple actors involved.

Eksote, one of the forerunners in Finnish public health care, faced many challenges when trying to implement the OST process. Based on the experiences in other diagnostic processes [47], Eksote decided to apply an agile business process development process to the opioid substitution therapy process and to develop a CDSS to support the process. The developed CDSS helps Eksote to manage the process workflow and to standardize the diagnostics tools used in the various phases of the process. The developed CDSS is linked to the other CDSS solutions in the Eksote mental health care unit and thus an overall view on a patient can be maintained.

The developed CDSS for the OST process has proven to be an effective tool. However, there are further development needs mainly with regard to the integration of the CDSS with the patient health record system.

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Publication IV

Kemppinen, J., Korpela, J., Elfvengren, K., Polkko, J. and Tuominen, M.
Redesigning Mental Health Care Service Processes to Increase Productivity

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Juha Kemppinen[2 , Jukka Korpela[1, Kalle Elfvengren[1, Timo Salmisaari[2 and Markku Tuominen[1

Redesigning Mental Health Care Service Processes to Increase Productivity

[1)] School of Industrial Engineering and Management
Lappeenranta University of Technology
Skinnarilankatu 34, FI-53850 Lappeenranta, Finland

[2)] South Karelia District of Social and Health Services, P.O. Box 24, FI-53101 Lappeenranta, Finland
juha.kemppinen@eksote.fi

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Abstract

This paper presents a case study of rethinking the diagnostics process management model in the mental health and addiction care services unit of South Karelia District of Social and Health Services (Eksote) in Finland. The mental health care services unit at Eksote has transformed to a best-of-breed organization with high productivity. By re-engineering the processes, establishing a new organization model and creating an extensive decision support system to enforce the implementation of the new processes, the mental health and addiction care service units achieved a significant increase in productivity and patient lead time, saved costs and lifted the quality of the diagnostics processes to a new level. The paper describes the re-engineering process of the mental health and addiction care service units, and proposes a generic framework for increasing service production efficiency in public health and social services units.

1. Introduction

The public health care and social services sector in Finland is under increasing pressure to raise productivity. The operating costs must be decreased while the service level must be maintained or even increased. In order to respond to this challenge, health care and social services organizations need to re-engineer their service production processes.

This paper presents a case study of rethinking the diagnostics process management model in the mental health and addiction care services unit of South Karelia District of Social and Health Services (Eksote). Eksote is a forerunner in health and social care services development in Finland as it combines primary and secondary health care, elderly care and social care in a totally new way covering eight municipalities that were earlier working independently. Integrated mental and addiction care enable patients to have integrated care in one place and not dropping between the services as it quite common in separated mental health and addiction care units.

During the past three years, the mental health care services unit at Eksote has transformed to a best-of-breed organization with high productivity. The starting point was a fragmented mental health and addiction care organization with low productivity levels, long waiting times for patients and ineffective diagnostic processes. By re-engineering the processes, by establishing a new organization model based on the new processes and by creating an extensive decision support system to enforce the implementation of the new processes, the mental health and addiction care service units achieved a significant increase in productivity and patient lead time, saved costs and lifted the quality of the diagnostics processes to a new level.

The paper describes how the transformation of the mental health and addiction care service units done in practice. The paper proposes a generic framework for increasing service production efficiency in public health and social services units. The paper contributes to both academic research and to practitioner perspective by presenting a proven approach to solving a challenge that most public health and social care services organizations are facing today.

2. Mental health and addiction care services at Eksote

Eksote has a tax-funded overall budget of 370 million euros. Eksote is responsible for delivering patient-oriented care to the approximately 130 000 citizens of South Karelia. It employs 4 100 people of which about 350 are working in the integrated mental health and addiction care unit. Eksote operates in a geographical area of over 5 600 square kilometers, 200 kilometers long and 100 kilometers wide.

Mental health care in Eksote is centralized in the integrated mental health care and addiction care unit called Miete. The annual budget for mental health and addiction care (Miete) is about 28 million euros. Open ward consists of walk-in 24/7 emergency and special clinic (MTPA), health care center psychiatry in municipalities and addiction clinic for acute and subacute cases. Open ward rehabilitation services for chronic patients include day-care facility (Veturi), ambulatory nurses (Liito) and rehabilitation units (f. Ex Parkki, which is rehabilitating back to work). Inpatient facilities consist of two psychiatric departments and one addiction inpatient center (Pajarila, for withdrawal and longer term treatment for addiction patients).

In the beginning of 2014 adult psychosocial services were integrated to Miete which allows for unifying the services of Miete patients, unemployed people and public employment agency clients.

3. Improving productivity in health care

There is a growing pressure on public health care services in Finland to increase their efficiency and productivity. The general goals are reduction in costs and waiting times, increases in quality, employee motivation and customer satisfaction.

Answer for productivity problem has been searched from management philosophies that, for other industries, offer more productive and cost-effective ways of organizing and delivering services. These management philosophies are for example the process re-engineering methodologies Six Sigma and Lean Thinking (Radnor & Boaden, 2008). Over the last decade process re-engineering methodologies have been applied widely across the healthcare service (IHI, 2005; NHS, 2006; Proudlove et al., 2008;

Young & McClean, 2008; Zidel, 2006). These process re-engineering methodologies were characterized as reducing waste and adding customer value through re-configuring organizational processes. Lean Thinking seeks to reconfigure organizational processes to reduce waste and improve productivity based upon the application of analytical tools and techniques coupled with creating a culture of continuous improvement (Radnor et al., 2012).

Holden (2011) critically reviewed 18 articles describing the implementation of Lean in 15 emergency departments in the United States, Canada and Australia. Emergency departments face problems with delays, crowding, cost containment, and patient safety. To address these and other problems, the reviewed emergency departments had implemented Lean Thinking to their operations. According to Holden (2011) patient care usually improved after implementation of Lean, with many cases reporting decreases in length of stay, waiting times, and proportion of patients leaving the emergency department without seen.

However, Waring & Bishop (2010) states that Lean might not be the easy remedy for making both efficiency and effectiveness improvements in healthcare. Lean follows in a line of service improvements that bring to the fore tensions between clinicians and service leaders around the social organization of healthcare work (Waring & Bishop, 2010).

Productivity has often been tried to be enhanced by developing new information systems to support the health care processes. Health information technologies can improve medical practices, assist the decision-making process by facilitating access to good practice guidelines, simplifying the prescription of diagnostic procedures, and producing reminders (Lapointe et al., 2011; Kaushal et al., 2006). Some studies show that it can lead to greater productivity among professionals, and lower costs (Sidorov, 2006; Thouin et al., 2008). However, some findings on the effectiveness and efficiency of health information technologies remain inconclusive (Kazley & Ozcan, 2008; Meyer & Degoulet, 2008). Some studies have even suggested that, in some cases, information technologies implementations appear to be counter-productive (Chaudry et al., 2006). Moreover, according to the literature in information systems, not many health information technologies implementations have been successful (Kaplan & Harris-Salamone, 2009; Ludwick & Doucette, 2009).

Common productivity challenges

Porter & Teisberg (2006) stated that health care is on a collision course with patient needs and economic reality. Quality was just as big an issue as cost. There was not just too much care, but also too little care, and the wrong care.

The combination of high costs, unsatisfactory quality, and limited access to health care has created stress and frustration for all participants – patients, employers, physicians and other providers, health plans, suppliers of drugs and medical devices and governments. Porter & Teisberg (2006) set a new vision of health care system in which every actor focused on improving value as measured by health outcomes per dollar spent. Affordability and accountability of the delivery chain must be ensured. In mental health and addiction care cost accounting are being notoriously neglected (McClellan et al., 2010). In the movement toward integrated, patient-centered care, the accountable care organization (ACO) might be regarded as the ultimate player, a multidisciplinary system built around the principles of collaborative care, financial rewards based on cost savings, and performance against quality measures (Moran, 2013).

4. Productivity challenges at Eksote: the starting point for development

Aligning the psychiatric care delivery value chain with all different actors in order to produce value to psychiatric and addiction patients was the main vision when the development of the Miete organization was started in Eksote. The mental health and addiction care delivery value chain was defined in 2009. There were enormous barriers to access mental health services as there were three to seven week waiting lists to psychiatric care. Primary care physicians were making referrals to the mental health clinic, but they were obliged to answer to the referrals by themselves because patients were unable to get psychiatric consultation in proper time. Thus, referrals were the main bottleneck for accessibility.

Another major source of efficiency was scheduling appointment time. After access to treatment, there was a long delay in getting the next appointment time. The nurse on call could not give the next time to the patient immediately after the first appointment. The Miete employees had their appointment times in their paper calendars, which caused real barriers to access treatment. Especially the nurse who discharged emergency patients did not have any opportunity to give next appointment time to the patient. She had to wait for the next meetings, where the appointment time could be arranged and given to the patient.

The third main problem area was that the structure of the mental and addiction care delivery process was fragmented, uncoordinated and broken. Lack of overall care delivery value chains, treatment of patients was fragmented and usually delayed by inefficient face-offs. Patients, who were in psychiatric and addiction care, were circulating between the nurse´s office, hospital (acute and long term) departments and day care units. 30 % of patients were forming “inside markets”, because of lack of planned overall care delivery chains. These inside markets were blocking access to services and increasing turnover time of patients in psychiatric care. Clinical challenges in the treatment of patients were solved by referring the patient to some other facilities without a proper plan for further treatment.

One of the problems caused by the functionally and separately organized mental health and addiction care was that patients were dropping in “care gaps”. This meant that either the needs of patients with dual diagnoses were not treated properly, or they were not suitable for the narrow-minded treatment based on categorizing patients to ‘psychiatric patients’ and ‘addiction patients’.

In the Eksote psychiatric hospital, there were four departments, which were overcrowded most of the time because of the unscrupulous access to psychiatric open ward. Inpatient treatment episodes were short and numerous. There were revolving door syndromes in psychiatric patients. Psychiatric care was separated between inpatient and outpatient, and treatments were not joined or aligned. There were almost hostility and accusing attitudes between the open ward and psychiatric hospital employees. The interfaces between the organizations were inefficient and poorly coordinated. The treatment circumstances on both sides of the interface were unknown to both care providers. There was only minimal joint activity. The care delivery chain included previously only the mental health care center and the psychiatric departments. The fragmentation of psychiatric care was most apparent in the psychiatric nursing homes.

Due to the many problems and challenges, the productivity of mental and addiction care was at a very low level. Without proper integration of different work force of mental health and addiction care, employees were lamenting over exhausting workload. Instead of real collaboration, every employee did solitary efforts to rehabilitate their patients. Psychiatric nurses had on average 2.5 direct patient visits

per working day. The nurses spent over half of the working day on indirect patient duties, which usually added no value for the patient. A lot of productivity was lost in many ineffectively held meetings, which were held mostly in vain because they did not add proper value for the patient care. E.g. Nelson & Economy (2010) state that approximately 53 % of all the time spent in meetings is unproductive, worthless, and of little consequences.

Management of employees was based on affects, because there were not any proper process metrics to monitor, like e.g. what the employees were doing, how many patients each employee had, or a functional group had per day, month or a year.

5. Redesigned operating model

5.1 Objectives for development

In order to overcome the challenges, Eksote and Miete defined setting up an integrated psychiatric and addiction care unit as the main objective. This had not been done earlier in Finland and thus no existing models were available.

The organizational challenge was to make the separate functional psychiatric and addiction care units to function as an integrated process organization. To operate according to a joint process was a substantive change in the psychiatric and addiction care employee's mindset. Furthermore, access to treatment needed to be more straightforward without excess steps and delays in agreeing an appointment time, scheduling and further treatment. Care in general and transactions in specific needed to be efficient and smooth. The interfaces between treatment and rehabilitation needed to be planned in advance.

The care delivery chain must distribute value for the patient through the entire care cycle in different treatment facilities. Miete´s new teams needed to improve efficiency of the workflow, to standardize diagnostics process and better information flow and coordination. New teams had to be formed according to walk-in and patient-centered service processes. The entire cycle of care needed to be planned according to a smooth and efficient patient path, not only according to the needs of the organization and employees.

One important objective was to introduce a new management style. Management needed to be based on mutually agreed metrics and KPIs instead of personal relationships and affects.

The financial objective was to keep the budget at the same level for the coming years despite the increasing costs. The challenges were to find savings, to reallocate the existing resources and to remove barriers to effective care. One way of reducing cost is to reduce face-to-face visits and increase electronic transactions.

5.2 Actions taken

In process thinking the client/patient and his/her needs are the beginning and ending principle of process (Laamanen, 2009). In Miete, the decision was to create the processes according to the client/patient needs. Miete was organized around the client/patient path in integrated psychiatric and

addiction care. The process metrics dashboard was introduced to monitor volume and amount of processes.

Integrated psychiatric and addiction care needed to be planned as joint processes. The entire care cycle of client/patient in Miete was established. Inpatient treatment was lessened and the open ward was widened. Resources to improve psychiatric and addiction care in general, and open ward in specific, were acquired by closing two inpatient departments down. The work force from the two closed psychiatric hospital departments was placed to work in the open ward with the primary care workers and long-term rehabilitation of chronic patients. The employees from the inpatient unit were transferred to the open ward and day care, which was broadened. In the redesigned organization the day care unit proved to be unnecessary and was subsequently closed. The employees were transferred to open rehabilitation units.

The walk-in emergency policlinic (MTPA) was opened to solve accessibility difficulties. Clients/patients did not need referrals, which had been the worst bottleneck to accessibility. Service and patient care were organized as patient-centered and as lean as possible. The nurse on emergency duty was privileged to reserve an appointment time to any electronic appointment time schedule of any employee, doctors included. The appointment time schedules of every employee were made electronically open and visible to any other employee to alleviate collaboration. The entire clinic appointment time schedules of each employee (doctors included) became electronically available in order to facilitate consultation of the patient by all needed Miete employees during the same visit.

Non-value events in patient care cycle process were scrutinized. All the meetings in the adult open ward were terminated altogether, and those prevailing meetings were prepared with a written agenda and electronically published conclusions open to everyone. E-mail groups were organized in order to deliver those meeting times, reports and other messages efficiently. Patient messages were delivered in the security line, which had been underused in the electronic patient record system (Effica).

Quality control needed a decision support system, which was developed. Stable quality of care chain was assured by an external clinical decision support system (CDSS). The CDSS enabled standardization of evaluation, diagnostics, treatment and rehabilitation of the clients/patients. The decision support system for evaluating, diagnosing and monitoring patient care of adult ADHD-patients was established first (Kemppinen et al., 2013). The second part of the CDSS supported the evaluation of work ability of psychiatric patients (Kemppinen et al., 2014). Later a more general decision support system of psychiatric care was developed to guide the overall psychiatric care delivery value chain. The CDSS allowed monitoring different processes in up-to-date manner.

Miete launched own eHealth-applications: an electronic questionnaire of most common psychiatric and addiction diseases, which a to-be-patient could fill in the Internet and which was steered to the psychiatric and addiction employees if the cut off limits surpassed.

5.3 Positive experiences

The reengineering of the psychiatric care delivery value chain abolished the waiting lists altogether. Patients could come to ‘the walk-in policlinic’ without referrals and could get instant consultation on a 24/7 basis. Accesses to psychiatric care abated and about 1000 new patients emerged (from about 1 500 to 2 500) and about 3 000 new visits of those patients (from 7 000 to 10 000 visits) per first year in the

new organization. New untreated patient groups were adult ADHD patients, young drug addicts and insomnia patients. After that first year of reengineering psychiatric care, there was not any remarkable increase in either new patients or patient visits. Unmet psychiatric care requirements have saturated.

Productivity of employees rose from 2.5 direct patient appointment times to 4.2 in three years. Productivity increased without any extra budget or workforce resources. The work environment became invigorating and proactive. There were no increases in sick-leaves of employees 2012-2013.

Psychiatric departments adopted a new patient-centered treatment philosophy. New patient groups have entered the departments, mostly untreated addiction patients. The induction of opioid dependence substitute treatment started in Ps1-department. Inpatient profiles changed, and addiction patients share increased, which resulted to shortened inpatient treatment episodes. The new philosophy of treating patients has lowered coercions and seclusions about 80 % in two years. The workplace environment has improved for patients and employees. Half of the psychiatric departments were terminated without any problems. The two prevailing inpatient departments were no more overcrowded. The utilization rate was about 80 %. The plan is to reduce psychiatric inpatient beds further to about 3 inpatient beds for 1 000 inhabitants.

Nowadays 8 000 Finnish mental health long-term patients live in nursing homes. The tendering process of nursing homes in Miete saved a few million euros at once. Now the treatment of patient in nursing homes is more aligned with the care delivery value chain of Miete.

Miete, mental and addiction care of Eksote was economically a success story. Mental and addiction care was the only area in Eksote, which was able to make economic surplus – and in three years in a row now. Economically mental and addiction care performed 10 % better than other sections of Eksote. Budget deficits in whole Eksote were 42 million euros in four years. If each other section could have done the same what was done in the mental and addiction care, there had not been any budget deficit in Eksote.

Mental and addiction care in Eksote became in three years the forerunner in health and social care services development in Finland. National customer organization nominated Miete in 2013 for the best two mental health organizations in Finland. Many facilities in Finland are adopting Miete´s way of organizing services and Miete has become a famous benchmarking organization.

Eksote became a popular employer where many different mental health and addiction professionals applied for a job. There are not no-open professional posts any longer. Especially physicians and psychologists, who have been earlier difficult to recruit to the organization, even with extra salaries, are asking for working possibilities in Miete.

5.4 The challenges in the re-engineering process

Fragmented psychiatric and addiction care was a result of poor management in mental and addiction care. Without proper management, delivery chain was without steering and employees had invented their own interests and ways of working in psychiatric and addiction care. The interests of employees were seldom aligned with value in patient care.

In the beginning the changes did not interest the previous key personnel, psychiatrists and

psychologists and they were reluctant to work in the new way in the newly organized facilities and many of them left the company.

Many fast changes in the new integrated mental health and addiction organization collided with the attitudes of old employees, which used to work in fragmented care and did not know the principles of the process organization. Lots of energy and resources wasted to one clinic with enormous resistance to the changes, in which managers in charge threatened verbally and physically. The incidents left for the time poorly healed psychic wounds and hostility environment to further innovation of that clinic, which eventually terminated in order to ensure further development of Miete.

Many of the terminated clinic employees did have great difficulties adopting new roles in new teams. Some of them transferred even from mental health professionals to mental health patients.

Qualifications of the transferred employees did not match the demands of new posts. The nurses, who have worked years in inpatient facilities, were incapable or inflexible to adopt a more independent responsibility mindset in working open ward without support of the surrounding team. Some nurses left in sick leaves, and some left the organization.

6. Results achieved

6.1 Quantitative results

Reengineering mental health and addiction care service processes removed waiting lists altogether. Three to seven weeks' delays to treatment vanished easily by tracking the bottlenecks of the care delivery value chain.

The ideology and philosophy of MTPA is brief therapy orientation: incoming new patients treatment visits are limited to 20 visits. According to psychiatric literature 75 % of patients need fewer than 20 visits to accomplish significant recovery (approximately in 5-8 visits), if they treated at once, when the need of treatment aroused without delay. Only every fourth patient needs more than 20 visits (Hubble et al., 2003). These results were similar in Miete.

12 % more patients (from about 4 800 to 6 800 patients per year) entered the services; there was a leap in one year and no increase after that. Patient visits increased by 16 % (from about 87 000 to 110 000 visits per year) instantly but remained the same in the next years.

Depicting swim lanes from the present situation made visible overall view of the delivery chain to every employee. This 'new way' to illustrate delays, defects and variation in the mental health and addiction care opened the employees see their share of complete delivery chain. In a process organization, it was easier to monitor performance. The prevailing and new employees adhered and made their real contribution to the value-based delivery chain.

The sick leaves of employees did not increase in the time of reengineering. Many key personnel were changed. Turnover of physicians and psychologists was remarkable, over 50 % of both key employee groups changed. All the leading nurses of departments were replaced. New key employees, who were able to carry out reengineering, came to Miete.

Reengineering old and inefficient structures of delivering care, we liberalized resources, which were accountable in real savings. In Miete achieved about 5 % budget saves in net costs 2010-2012 (over 3 m€, 4.08 $ of 60 m€, 81.8 $) (at the same time net costs in whole Eksote increased 11.2 %). The whole Eksote (integrated social and health care) has made over 40 m€ budget deficits in four years. Partly because the municipalities transferred their past years budget deficits to the found new organization. In spite of that Miete did budget surplus in every year, and if the whole Eksote could achieve same results, there is any budget deficit now in Eksote. In capitation principle municipalities could get their invested money back in year 2014. The entire Eksote did not accomplish the same reengineering their services as Miete did.

6.2 Qualitative results

The old fragmented mental health and addiction care was based more to solitary craftsmanship than coordinated collaboration. Two psychiatrists would give different diagnoses to the same patient between 32 and 42 percent of the time (Carlat, 2010). From the start the new organization it was clear that we needed a decision support system to align the diagnostic processes with the SCID (Structured Clinical Interview for DSM-IV Axis I and II Disorders) procedures despite the argued methodological and other problems these procedures include. The fundamental idea of SCID (first version in 1952 modest 130 pages, newest DSM-5 in 2013 plentiful 945 pages) was to standardize the diagnostic processes. Diagnostics process has standardized by clinical decision support system. Standardization of diagnostics processes achieved by CDSS created.

New previously undiagnosed and untreated patient groups emerged through the referral-free walk-in clinic. We defined the diagnostic processes specifically to the new patient groups, which we faced, in emergency visits (Kemppinen et al, 2013). It was not only doctors to align, but nurses, psychologists and occupational therapist, as well. The main purpose of the CDSS was the alignment of diagnostic evaluation and treatment processes, lately psychiatric workability evaluation process (Kemppinen et al., 2014). The CDSS was developed and is still being developed toward a general clinical decision support system for diagnostics.

There were no proper metrics of processes, when Miete was established. The perception was that it was impossible to get metrics from the most popular patient health record system (Effica in Finland), which was used. However, the problem was solved and metrics about patients, visits, employees and different unit's metrics are now available. A dashboard to monitor Miete processes was created. Monitoring exposed that nurses were using solely one category to register patient visit information, which meant that the reasons for the visits had not been recorded properly. The registrations did not give any chance to analyze the causes of the visits. Instructing the personnel to log visits in a new way made the statistics more reliable. In one, year, about 10 000 visits were recorded properly, and we got diagnostic information about the visits. Depression and anxiety disorder visits are the reason for about half of the visits.

7. Discussion

Redesigning mental health and addiction care service processes to increase productivity has been an invigorating enterprise. In quite a short time remarkable results have been achieved. Patients can walk

in 24/7 for advice, evaluation, diagnostics, treatment or rehabilitation. Service is faster than previous organization and easily accessible without obtaining any referrals from busy and overloaded general practitioners or occupational health care physicians. During the re-engineering project the number of patients increased by 12 % and the number of patient visits increased by 16 %. Miete was chosen as the best two mental health and addiction care units in Finland by national consumer agency in 2013.

Mental and addiction care services have saved money to municipalities. The existing resources were allocated in a proper way. Released resources from the past inefficient company have been used to develop a new efficient organization, without extra resources from the budget. At the same time, 5 % budget deficits have been achieved in a couple of years, over 3 m€ (4.08 $) of 60 m€ (81.8 $). Capitation principle did not offer any chances to reward employees. It meant that improving productivity diminished resources in Miete, which is a public tax-funded organization.

Redesigning Miete denoted turnover of the key employees: almost every physician, all psychologists and all head nurses were replaced. New social workers and a new occupational therapist joined the organization. Patient service interruptions were not in employee turnover. There were no increases in the amount of sick leaves in last two years. Work force demands of specialists have been solved by reengineering services, Miete is a desired work place in the South Karelia area and even broader area in Finland. Previous it was difficult to recruit employees to the key positions.

Overcrowded mental health departments are history now. A new and more human care was established in two prevailing inpatient departments. Constrains and seclusions have fallen by 80 % in two years. New patient groups had access to inpatient treatment. Opioid dependence substitute treatment inductions have demobilized from purchase services, which have saved tens of thousands of purchase services budget euros per year. Patients have not to travel hundreds of kilometers to get an evaluation or an induction of opioid dependence substitute treatment.

The developed CDSS has enabled more flawless mental and addiction care. Evaluation, diagnostics, treatment and rehabilitation processes have been aligned with the standard methods in psychiatry and addiction care. Quality of care has improved. Evidence based psychiatry and addiction care implemented in CDSS confirm up-to-date treatment for patients.

Significant progress has been made in Miete. Remaining challenges are to lean processes further and use Six Sigma to improve services further. Many interfaces to old functional units of Eksote are still with delay and there is a lot of variation. Coordination of the interfaces should be improved with other units in Eksote.

Value-based service delivery chain needs to be implemented more deeply as a guiding principle in developing mental health and addiction care. The processes, which do not create value for the patients will be removed, if they are not necessary non-value added processes.

Lean Six Sigma methods will be used to develop Miete in a scientific manner. Conflicts between the employer and employee about work performance were solved better with procedural data than feelings aroused in discussions without proper data.

The CDSS will be developed from a process-specific tool to a general process platform, which will facilitate the use of patient health records in daily work. E-Health mobile solutions to help ambulatory

work with the patient will be developed. Extra work of double recording of patient information will be solved with intelligent devices in IT-systems.

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Publication V

Kemppinen, J., Korpela, J., Elfvengren, K., Polkko, J. and Tuominen, M.
Increasing Productivity in Mental Health Care Services with an Integrated Process and Diagnostics Support System

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INCREASING PRODUCTIVITY IN MENTAL HEALTH CARE SERVICES WITH AN INTEGRATED PROCESS AND DIAGNOSTICS SUPPORT SYSTEM

Juha Kemppinen[1], Jukka Korpela[2], Kalle Elfvengren[2], Jussi Polkko[1]
[1)] Eksote, Valto Käkelän katu 3, FI-53100 Lappeenranta, Finland
[2)] Lappeenranta University of Technology, Skinnarilankatu 34, FI-53850 Lappeenranta, Finland

ABSTRACT

The public health care and social services sector in Finland is under increasing pressure to raise productivity. In order to respond to this challenge, health care and social service organizations need to re-engineer their service production processes.

The paper describes how the reengineering of the mental health and addiction care service units was done in practice in the integrated mental health and addiction care services in South Karelia District of Social and Health Services, Finland. The paper presents how the IT-technology was used to support and implement reengineered and redesigned business processes. The paper describes the developed Clinical Decision Support System that supports both the management of the process workflows and the diagnostics procedures. The paper contributes to both academic research and to practitioner perspective by presenting a proven approach to solving a challenge that most public health and social care services organizations are facing today.

Keywords: mental health care, productivity, clinical decision support system, CDSS, BPM.

INTRODUCTION

The public health care and social services sector in Finland is under increasing pressure to raise productivity. The operating costs must be decreased while the service level must be maintained or even increased. In order to respond to this challenge, health care and social service organizations need to re-engineer their service production processes. Reengineering is the fundamental rethinking and radical resign of business processes to bring about dramatic improvements in performance (Hammer, 1990; Hammer and Stanton, 1995). Process design determines performance (Hammer, 2007, Laamanen, 2009).

Health systems will need to address the needs of the rising numbers of individuals with a range of disorders that mostly cause disability but not mortality. Effective and affordable strategies to deal with this rising burden are urgent priority for health systems in most parts of the world (Vos, et al., 2012). It is estimated that, in 2030, depressive disorders will be the leading illness in causing years of full health lost due to diseases in the high-income countries.

There is not any definitive evidence that the incidence and prevalence of mental disorders are raising in Finland. The share of major depressive disorder in work disability has doubled in ten years, although the use of anti-depressive medications has increased by 500 % in the same time (Salminen, 2004). Only prescribing and using more medications will not solve the problems of mental health care. Rethinking business processes in mental health and addiction care was needed.

The idea that redesigning business processes– work that runs from the end to end across an enterprise– can lead to dramatic enhancements in performance, enabling companies to deliver greater value to customers in ways that also generate higher profits for shareholders – is seldom questioned (Hammer, 2007).

In general health care and social service organizations need to be redesigned in processes in order to face enormous challenges productivity and performance. Many physicians are working in a private sector alone or small groups, usually as the only physician in a team. It is not possible to call it "system". Nowadays even the integrated health and social care are fragmented in Finland and Europe (Rubin and Zorumski, 2012).

As in America this "small-scale, cottage-industry approach can deliver finely crafted services, but the quality of those services is variable, and costs are typically high. Coordination, standardization, quality improvement, and all the other factors that today make high-quality products and services available to more people rapidly and more cheaply than at any other time in history have yet to implemented in healthcare." (Cosgrove, 2013)

Many management styles have been proposed and tried to solve problems of health and social care. Reengineering is not just another management fad. Managing by reengineering is not a miracle drug. Reengineering is not just "fixing problems". It is hard and extensive work. It does not offer a single, narrow

technique to solve all problems; rather reengineering is a massive undertaking that entails rethinking every possible aspect of the business (Hammer and Champy, 2006).

Reengineering demands top-down management and at the same time the reengineering management must be on the genba. Genba means, more or less, the shop floor. The shop floor is the place where the needs of the patient, meet the work of the system, the front line. Genba is a place, where the actual value is created. "Healthcare overall today suffers from enormous and costly distance between those who establish the context of health care (payers, policymakers, regulators and even educators on the one hand) and those who give the care, day-to-day at the front line (on the other hand). As a result, context can become insensitive to the texture of the needs of the people who give and receive care, and the genba can become unhelpful and disconnected from the social and economic imperatives that shape the context. The result is waste, disarray, misunderstanding, and loss of pride and joy in work. Sound leadership and design are preconditions to systemic success." (Kenney, 2011)

Reengineering needs to align with the development of IT-systems. From its inception, reengineering has been a close partner of information technology. IT-technology enables the very business processes to be redesigned. Reengineering and IT have a mutual relationship. Information technology delivers little payoff without reengineering. It is just to make stupid things faster. Without information technology, little reengineering can be made. Reengineering without IT is usually only a theoretical exertion. (Hammer and Champy, 2006)

The paper describes how the reengineering of the mental health and addiction care service units was made in practice in integrated mental health and addiction care services (Miete) in South Karelia District of Social and Health Services (Eksote). The paper presents how the IT-technology was aligned with reengineered and redesigned business processes. The paper proposes a generic framework for increasing service production efficiency in public health and social services units. The paper contributes to both academic research and to practitioner perspective by presenting a proven approach to solving a challenge that most public health and social care services organizations are facing today.

PROCESS DEVELOPMENT CHALLENGES IN MIETE

Miete Introduction

Eksote is a forerunner in health and social care services development in Finland as it combines primary and secondary health care, elderly care and social care in a totally new way covering eight municipalities that were earlier working independently.

Eksote has a tax-funded overall budget of 370 million euros. Eksote is responsible for delivering patient-oriented care to the approximately 130 000 citizens of South Karelia. It employs 4100 people from which about 350 are working in an integrated mental health and addiction care unit. Eksote operates in a geographical area of over 5 600 square kilometers, 200 kilometers long and 100 kilometers wide.

Mental health care in Eksote is centralized in the integrated mental health care and addiction care unit called Miete. The annual budget for Miete is about 28 million euros. Miete's redesigned care consists the open ward: a walk-in 24/7 emergency and special clinic (MTPA), a psychiatric health care center for the municipalities (psychiatric nurses and psychologists working with health care center personnel) and an addiction clinic for acute and subacute cases. Open ward rehabilitation services for chronic patients include day-care facility (Veturi), ambulatory nurses (Liito) and rehabilitation units (e.g. Parkki, which is rehabilitating back to work). The inpatient facilities consist of two psychiatric departments and one addiction inpatient center (Pajarila, for withdrawal and longer term treatment for addiction patients).

At the beginning of 2014 adult psychosocial services were integrated to Miete (that name changed to APSY at the same time), which centralizes and unifies the services of mental health and addiction care patients, unemployed people and public employment agency clients. At the beginning of 2015, the municipalities will be punished with a fine for 300 euros/ unemployed, if they do not have any activities to the people who have unemployed more than 300 days.

Challenges in the Processes

Miete did have all the classical problems of functional and hierarchical organization in the beginning reengineering. Before establishing the walk-in (24/7/365) clinic, there were three to seven weeks' waiting lists to mental health care services. When open ward patients did not get treatment from the open ward, there went to the somatic emergency care (over 6000 patients in 2009) or tried to get treatment from the psychiatric hospital. We did have "patient overflow" to inpatient treatment. There were four overcrowded inpatient departments in a psychiatric hospital. In order to have beds to incoming inpatient patients the turnover of patients were accelerating all the time. The psychiatric hospital had revolving doors – syndrome in treating patients because the patients did not get services in an open ward, in proper time.

Mental health patients were searching treatment from health care centers and occupational physician in order to get referrals to psychiatric treatment, because of a referral policy from primary care to secondary care. Usually it was two to four weeks waiting list to general practitioners and occupational physicians. General practitioners and occupational physicians did make referrals to the open

ward, but they did not get the consultation answer to their consultation in seven weeks.

In Finland mental health based sickness benefit legislation determines that after one to two months, mental health patient need certification from psychiatrist. General practitioners are allowed to suggest the sickness benefits up to 60 days. After 90 days, those who are employed need the certification from the occupational physicians in order to get social security allowances because of mental health. Local authorities in Kela (national social security system agency in Finland) were inventing exceptions to GP in South Karelia area, because the mental health patients did not get their psychiatric consultation in two months. The general explanation was that there were not enough doctors in psychiatric open ward. Miete did have a lack of psychologists, as well. Miete has tried to recruit the key personnel in vain, even with promised extra salaries.

Psychiatric and addiction care services were organized according to different task specialization and hierarchies in traditional functionally organized expert business. Miete had thus separated mental health and addiction care. Miete was segregating patients to mental health care and addiction care, although about 50 % of the most common patient group, depression patients are having both syndromes. These dual diagnoses patients fell between the strict lines of organizing patient care by expertise. Many times the patients were unfortunately either 'too psychiatric for addiction care or too addicted' for mental health care. Overall treatment processes of patients were fragmented. Employee, not by patient, prioritized the organizing principle of patient care.

The value chain of patient care included many inefficient handoffs. In one hand specialization to inpatient care and the other hand to outpatient care has led sub-optimization in overall patient care and the value chain of patient care. It was almost a hostility atmosphere between employees in both inpatient and outpatient care. Inpatient and outpatient employees behaved like functional rivalries. Employees worked in functional silos in patient care path, which did not provide value for the patient. The only one high-performance unit in the business of Miete, in the value chain of the patient, did not save the whole care path of patient.

Reengineering is about achieving operational excellence (Hammer and Champy, 2006). In the beginning, Miete did not have any proper metrics of operational level at all. Manager did not know what the employees were doing in the daytime and there was not any operational measurement at all. It was told that it was impossible to have specific metrics in patient record system, which is most commonly used in Finland. Miete invented a dashboard to monitor different operational metrics.

Firstly it was measured the productivity of open ward psychiatric nurses. The first measurement was: how many direct patient visits the employee did have per day, per week, month and year. Without metrics, it was heard a constant outcry from the employees that they had too many patients and too little time to treat them. Annually there was a continuous request for more employee resources. The results of measuring this one measurement of productivity astonished: average nurse did have 2.5 direct patient visits per day. An average nurse did spend six hours per day to do something else than direct patient work. Miete did not do the right things in operational excellence; Miete had much non-value for the patient practices.

In a literature approximately 53 % of all the time spent in meetings is unproductive, worthless, and of little consequences (Nelson & Economy, 2010). The liberated resources for example meetings can be allocated to the redesign processes (employees, time, facilities). The redesign means the specification of which people must perform what tasks, in what order, in what location, under what circumstances, with what information, and what degree of precision. Certainly, companies can use techniques such as Six sigma and TQM to ensure that employees execute methods correctly. However, redesigning processes is often the only way to improve their performance dramatically (Hammer, 2007).

In process thinking, the client/patient and his/her needs are the beginning and ending principle of process (Hammer, 2007, Laamanen, 2009). By processes, it is possible to develop an efficient infrastructure for continuous improvements (kaizen). Better productivity is achieved by processes. Processes connect vision and strategy of the business. The performance of the company is created in those core processes.

Requirements for Process Support

Designing new business processes involves more than rearranging workflows; who does what tasks, in what locations, and in what sequence. The old duties and qualifications are seldom maintained. To make the new processes work, companies must refine jobs more broadly, cease some jobs altogether, increase training to support these new jobs and enable more decision making power to the frontline personnel, and redirect reward systems to focus on processes, as well outcomes. (Hammer, 1990)

Enterprises to redesign processes must also have to reshape organizational culture to emphasize more teamwork, more personal accountability, and underline the customer´s importance. The roles and responsibilities must redefine so that managers oversee the entire processes instead solitary activities of an individual employee and develop people rather than supervise them. The information systems must realign so that they help cross-functional processes of the entire organization work smoothly rather than only support specific departments and specific tasks. (Hammer and Stanton, 1995)

Miete needed a clinical decision support system (CDSS) to reengineer business processes of Miete. At the beginning of reengineering it was decided, that Miete do not need patient referrals, which were causing ostensive obstacles in processes of Miete. The new walk-in clinic, MTPA, faced new patient groups. To adult ADHD patients Miete did not have care path at all. It was started Miete´s first CDSS-enterprise with an adult ADHD-patient and psychiatric work ability evaluation.

THE DEVELOPED CDSS ARCHITECTURE FOR MIETE

Eksote has utilized an agile business process management (BPM) process approach to the development of CDSS in the area of mental health care since 2011. The development platform is called Serena Business Manager (www.serena.com/products/sbm), which was chosen after it had been tested in other parts of the organization. The objectives Eksote wanted to achieve through the new approach were the following: (1) effective workflow management in order to ensure that all necessary steps in the processes are taken in a timely manner, and (2) process standardization in order to unify the diagnostics processes by enforcing the use of jointly agreed diagnostic tools, question templates and logic. The first CDSS implemented in mental health care in Eksote was the process solution to support the ADHD diagnostics process (Kemppinen, et al., 2013). The overall CDSS architecture was first presented by Kemppinen et al. (2014) and in this paper we expand the description of the architecture further.

Based on the positive experiences gained from the ADHD diagnostics process solution, Eksote decided to create a comprehensive CDSS architecture (Figure 1) that includes all the diagnostics tools in use, combines individual process solutions for all major mental disorders, and enables planning and management of the rehabilitation phase for each patient. Mental health care patients have often more than one disorder, and thus the decision makers at Eksote decided that it is of utmost importance to maintain an overall view on each patient, i.e. in which diagnostic processes a person is included and which diagnostic tools have been applied to the person.

The overall CDSS architecture consists of three layers:

1. The tool layer includes all individual diagnostics tools that are currently in use at Eksote. The reason for creating a separate layer for the diagnostic tools is that the tools are not necessarily specifically used for only one mental disorder. As the diagnostic tools are included in the CDSS as individual modules, they can be used across the various diagnostic processes in an effective way.
2. The process layer consists of the process solutions for diagnostics, rehabilitation planning and patient placement. The diagnostics process solutions are used for managing the process workflows and for combining the right set of diagnostic tools for each mental disorder. The process workflows guide the users through the needed process steps in a strict manner. However, the users must always decide specifically which diagnostic tools are to be used for each patient. Currently there are three diagnostics processes in use: ADHD, work ability evaluation and opiate replacement therapy. New diagnostics processes can be added easily to the architecture.

The process solution for rehabilitation planning provides a structured way for deciding on the needed further actions on the basis of the findings in the diagnostics processes. A comprehensive plan is defined for each patient and this plan is used as the basis for the patient placement process solution. The objective of the patient placement solution is to ensure that each patient will get further treatment in a facility that matches the requirements defined in the rehabilitation plan. The patient placement solution supports the decision makers in managing and balancing the demand (patients) and the supply (available rehabilitation places in various facilities).

3. The customer management layer provides the users with a tool for patient management and enables overall coordination across different processes and domains. By entering a patient´s name and/or social security number the users can see what diagnostic tools have been applied to the patient, which diagnostics processes the person has been involved in, what rehabilitation plans have been defined for the patient, how the plans are being executed and where the patient has been placed for further treatment. The overall view on the patient removes the earlier problem that a person was included in multiple diagnostic processes and the same diagnostic tools were applied within a short timeframe. The overall view gives a patient-centric view on the processes and tools, showing all relevant information across all diagnostic processes. Laws and regulations permitting, the information can be shared easily with different organizational domains in order to avoid overlapping diagnostics processes.

Due to the layer-based structure, the developed CDSS can be expanded to cover all diagnostic processes used at Eksote. When a new diagnostic process workflow is added to the process layer, all existing diagnostic tools are available and new specific tools can be added to the tool layer if needed. The new diagnostic processes and tools are then connected to the customer management layer to enable a holistic view on the patient.

THE ADHD AND WORK ABILITY EVALUATION PROCESSES

In November 2010, Eksote established a new acute emergency clinic where referrals are not needed for the

adult mental and substance abuse patients. The emergency open clinic met many new untreated adult patients, who have possibly ADHD. The clinic did not have any procedures for adult ADHD-patient diagnosis or treatment, and faced the problem of diagnosing adult ADHD-patients, who have almost always many comorbid psychiatric disorders. The clinic has also a need to make the diagnoses more accurate and to establish efficient assessing and treating processes in unselected populations, who came to the new emergency department. To overcome these problems the mental health and addiction care professionals of the emergency clinic started to develop a computer-assisted diagnostic process, which includes the whole complex ADHD-diagnosis procedure. The clinic needed to establish a program for adult ADHD patients, and thus evaluation, diagnosis and treatment process by a multi-professional team was developed. The multi-professional evaluation group includes a psychiatrist, one psychologist, an ADHD nurse, an addiction nurse, a social worker and an occupational therapist.

The outcome of the first main phase of the development project (process definition) was the new ADHD diagnostics process workflow (Figure 2). The new workflow is based on the needs and requirements of Eksote and it consists of seven main phases. The main phases are the following:

1. Enter a new patient: The first step in the process workflow is to enter the details of a new patient into the ADHD diagnostics solution. The information entered at this stage includes the personal details of a person but also an evaluation of the new patient's situation by a social worker.
2. Organize the preparatory diagnostic meeting: The second main step in the process is to organize a preparatory diagnostic meeting where the information of each new patient is reviewed and the decision concerning the need for various psychiatric examinations is made. The participants of the preparatory meeting are the members of the ADHD team: the psychiatrist, the ADHD nurse, the social worker and the psychologist. The outcome of the meeting is a task list for each meeting participant, which shows which examinations they have to carry out for each patient.
3. Carry out the examinations: During the third step of the process workflow, the members of the ADHD team carry out the defined examinations for each patient. The examinations are carried out by using the diagnostic tools built into the ADHD solution. The results of the examinations are recorded in the ADHD solution giving thus visibility to the progress of the process.
4. Organize the final diagnostic meeting: The fourth step of the process is the final diagnostic meeting where the decisions concerning the further treatment or rehabilitation of each patient are made. The final meeting is organized only when all defined examinations for each patient have been carried out. The developed ADHD solution shows which patients are ready for the final meeting thus eliminating the danger of having meetings organized in vain.
5. Place the patient to rehabilitation: Based on the decision of the final diagnostic meeting, the patient is placed to rehabilitation. The duration of the rehabilitation period is individually defined.
6. Evaluate the patient's condition: The condition of the patient is diagnosed on a regular basis while he/she is in the rehabilitation. The ADHD solution is used for carrying out the examinations and for comparing the results to the earlier ones. Depending on the progression in the patient´s condition, decisions are made concerning the rehabilitation and the methods for further treatment.
7. Place the patient to the decided rehabilitation or treatment: The final step of the process is to place the patient to the decided long term treatment or rehabilitation.

After the successful ADHD-process implementation, a process for evaluating the work ability of mental health care patients was put in development. The work-ability evaluation process provides the users with workflow management of the diagnostics process, tools for supporting the diagnostic examinations and a tool for managing patient-specific information across various diagnostics processes.

The developed work-ability evaluation process is currently in use in Eksote. The members of the work ability evaluation team have defined the process workflow according to the needs and requirements of Eksote (Figure 3). The steps of the development process are very close to the approach, which was used in the ADHD-solution. One of the main objectives of Eksote is process standardization, and thus the main steps in work ability evaluation are closely related to those of the ADHD solution, although the actors and the actual content of the process steps are different.

There are multiple different actors involved in the process for both ADHD and work ability evaluation processes. The diagnostics tools used by these actors have been built into the process solution as an integrated part. Thus, when the members of the team carry out the examination of a patient, they choose the needed diagnostic tool in the solution menu and fill in the form that opens. The main diagnostics tools are the following:

- nurse: ASRS 1.1 and DIVA 2.0
- social worker: Designed functioning level questionnaire, SOFAS, AUDIT
- psychologist: DIVA 2.0, WAIS-III, WMS-III and a wide range of specific neuropsychological assessment tools (the results of these methods are modified for the solution)
- addiction nurse: addiction evaluation and SDS, part of EuropASI and PRISM

- psychiatrist: BPRS, MADRS, MDQ, YMRS, PROD and broadened SCID
- occupational therapist: AMPS, MOHOST, OSA and HOME assessment.

The diagnostics tools provide the actors in the process with a standardized, easy-to-use approach to evaluating the condition of a patient. Most of the questions in the tools have a drop-down list of alternative choices for answers. Furthermore, deductive logic has been built in where possible meaning that the process solution proposes a conclusion based on the information entered. The built-in deductive logic is based on both generally used and specific psychiatric rating scales and diagnostic criteria.

The created solution automatically composes a summary of the results of all diagnostics tools thus providing a complete overview of the analyses conducted on a patient. Creating the summary is a straightforward task as all diagnostic tools are an integral part of the solution. Thus, no interfaces with other systems are required. The summary shows the consensus view of the team on the condition of each patient as the potential differences of opinion have been addressed in the joint final diagnostic meeting with regard to each patient.

EXPERIENCES AND FURTHER DEVELOPMENT PLANS

"All development projects are touch to putt off, but process-based development is particularly difficult. Most companies tend to overlay new processes on already established functional organizations. However, the appurtenances of a traditional business – such as job definitions, performance measurement systems, and managerial hierarchies- do not always support high-performance processes. If the employees do not know the context in which they work, they will be prone to making decisions that are not in the best interests of the entire process. A high-performance process extends across functional boundaries, so a senior executive must supervise it. Without such a person, the process will not gain traction within the organization" (Hammer, 2007). Reengineering Miete to the process-like business was a hard work and still is in order to maintain the benefits achieved.

As a newly reengineered organization, Miete achieved many fast benefits. After removing jurisdictional referrals altogether, waiting lists disappeared. Patients will get their treatment at 24/7/365 and the patient satisfaction was one of the best of Eksote. Miete was elected 2013 the best two mental health organization by national customer organization in Finland. In 2014, Miete was awarded a significant national commendation, which was earlier awarded, for example, to Rovio (creator of Angry Birds).

Establishing the process organization did not fit some key employees, who left the company. Turnover of physicians and psychologists was large. Those who left the company felt, that it would impossible to handle patients in process-like. Many of the key employees who left or were chosen to perform changes did not have qualifications to implement the changes and they were changed. Reengineering is itself a process for reorganizing work, not only downsizing or eliminating workers. (Hammer and Champy, 2006)

Most middle managers were changed. This managerial hierarchy in the corporation is "the Death Zone of reengineering" (Hammer and Stanton, 1995). Reengineering creates an organizational environment in which hierarchy is purposely diminished, front line workers are more skilled, and organizational structures are more flexible. The emphasis in this environment is on work done, not on administration. Learning how to work and manage in such an organization is a critical requirement for harvesting the benefits of reengineering. (Hammer and Champy, 2006) At the beginning of reengineering, they was many criticizers of a newly flatten hierarchy and increased responsibility of frontline workers without monetary compensation.

Many employees, who were hesitant about the changes at the start of reengineering, were delightfully surprised how smoothly and efficiently the new processes work. The employee work satisfaction was above the strategy of Eksote planned. The recruiting new employees were oversupplied, including physicians and psychologists, which were impossible to recruit earlier even with extra incentives. The unexpected new way to treat integrated mental and addiction care patient were eventually greeted enthusiastically.

Implementing the new processes with CDSS made the changes easy to understand. Process thinking was visible by CDSS and CDSS made it possible to monitor business processes. Productivity metrics rose from 2.5 direct patient visits per day to 4.5 direct patient visits per day in two years. Budget savings were 17 % in two years (about 5 million euros from about 28 million euros). CDSS will be covering all the diagnostic processes of an integrated addiction and health care and it will provide with one glance a holistic picture of patient care.

For the further development, an integrated addiction and mental health care need to deepen the understanding of patient care path process as a whole. The 'big picture' of care processes will be aligned with value for patients. Value in health care is determined in addressing the patient´s particular condition over the full cycle of care (Porter and Teisberg, 2006). With proper metrics, the integrated care organization will achieve the knowledge of which activities are value and non-value for the patient. PEMM (Process and Enterprise Maturity Model) is worth of considering as a vehicle in deepening knowledge of know-how of the care processes (Hammer, 2007).

CONCLUSIONS

Many authors have criticized reengineering. Accusations have been that reengineering is too focused or even 'a war on non-value adding work'. It results in a rapid loss of what had been built over many years: human capital and employee loyalty. Reengineering has been seen as an indiscriminate downsizing, an up-down management fad, too dogmatic (Smith and Fingar, 2003).

Reengineering is about a change from functional process thinking, which is essential for a radical restructuring of business process. The experience indicates that this does not go without the strategical preparation and human factor. Internal enterprises transformation depends particularly, on a change of human beings themselves. A firm culture played an important role in management development. Stable and integrative connection of firm culture, with firm strategy, is a reliable basis for enterprises success. They together create a source of positive synergic effect (Vavrinci, 2002).

Also, there are successful enterprises to apply reengineering to medicine (Auerbach et al., 2014; Lilly et al., 2014). In Miete, it was found that reengineering and easy iterative IT applications can help implementation of strategic and operational goals of the organization. Reengineering and clinical decision support system makes it convenient to get rapid benefits of redesigning an integrated mental health and addiction care.

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FIGURES AND TABLES

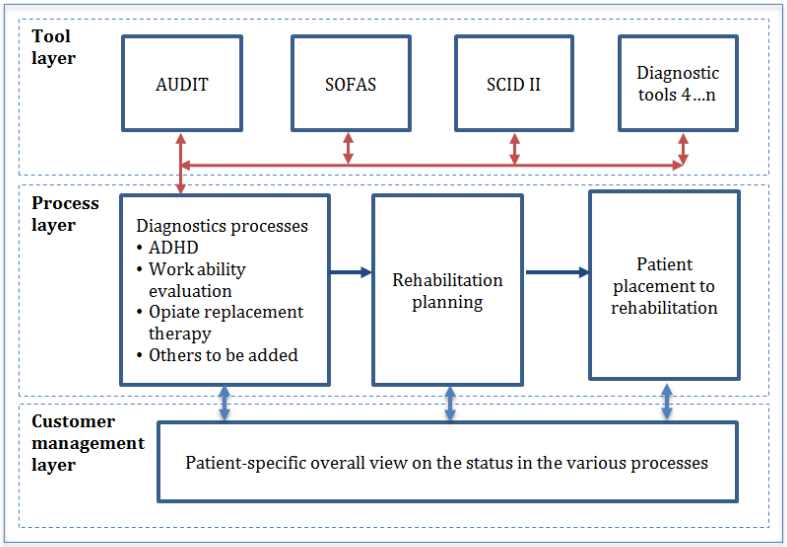

Fig. 1 Architecture for the mental health care system

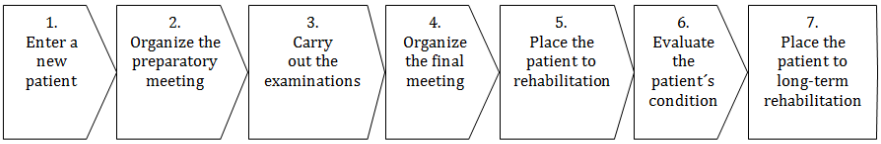

Fig. 2 Adult ADHD diagnostics process workflow

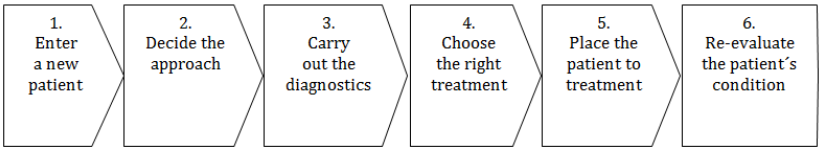

Fig. 3 Work ability evaluation process workflow

Publication VI

Kemppinen J., Korpela J., Elfvengren K. and Polkko J.
Improving the Productivity and Efficiency of an Integrated Mental and Addiction Care – An Application of the Theory of Constraints and Five-focusing Step to Evaluation of Adult ADHD Patients

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Improving the productivity and efficiency of an integrated mental and addiction care – an application of the theory of constraints and five-focusing step to evaluation of adult ADHD patients

Juha Kemppinen, MD[1], Jukka Korpela, DSc (Tech.)[2], Kalle Elfvengren, DSc (Tech.)[3], Jussi Polkko, MSc (Tech.)[2]

[1] South Karelia District of Social and Health Services, Lappeenranta, Finland, [2] Chainalytics, Espoo, Finland, [3] Lappeenranta University of Technology, Lappeenranta, Finland

Juha Kemppinen, South Karelia District of Social and Health Services, Valto Käkelänkatu 1, 53301 Lappeenranta, Finland, FINLAND. Email: jhkmppnn@gmail.com

Abstract

This paper suggests that the productivity and efficiency of social and health care services can be improved considerably by redesigning and streamlining the processes. The paper presents the theory of constraint (TOC) and five-focusing step (5FS) solution to the productivity and efficiency problems of an integrated mental and addiction care outpatient clinic (MTPA-model) team. The MTPA is an integrated walk-in clinic where clinical decisions on key patient groups are supported by a clinical decision support system (CDSS). One of the critical service processes of the MTPA is a CDSS-assisted adult ADHD diagnostics process.

The aim of the paper is to describe the improvement of productivity and efficiency of a typical multidiscipline team of MTPA-model. A combination of the action research approach and design science research was applied to solve the emerging service process problems and create a CDSS. The paper outlines the principles of the TOC applied for the established CDSS-assisted adult ADHD diagnostics process. The bottlenecks or constraints of an adult ADHD process are defined. The data from the designed CDSS and the currently used electronic health record provided material for applying the 5FS methodology for improving the productivity and efficiency of the adult ADHD process.

We suggest that applying the 5FS-process of TOC to mental and addiction care processes generally, and to the multi-professional team especially, is an effective way to negotiate constructively about the bottlenecks or constraints of the process and improve the productivity and efficiency of integrated mental health and addiction care services and operations. Based on the results, a general framework for improving the productivity and efficiency of a multi-professional team and health care services organization by applying the 5FS methodology is proposed.

Keywords: social and health care, mental and addiction health care, theory of constraints, five-focusing step, efficiency, clinical decision support system

Introduction

In recent years, the requirements for productivity and efficiency in social and health care have increased. The current Finnish government announced it as the most important decision of the new government [1]. About 60 percent of collected taxpayers' money is spent on social and health care services in Finland annually. The economy of Finland has plummeted in the 2010s, which has made it inevitable to think of allocating the existing financial resources more appropriately, e.g. by redesigning and reorganizing Finnish social and health care in a new way. One of the most important decisions in Finland in the 2010s will be how to allocate taxpayers' money in the future. Just cutting costs in social and health care will not be enough. The Finnish social and health care must be reorganized and implemented in a new cost-efficient manner. The biggest challenge for the Finnish government is the reorganization of social and health care; a task which earlier Finnish governments have tried to accomplish in vain for the last thirty years.

In the literature of productivity and efficiency, it has been stated that the working environment of social and health care is unique, complex, turbulent, and stochastic in its processes. Thus, the measurements of productivity and efficiency borrowed from the manufacturing industry do not fit comfortably in social and health care [2-4]. Dettmer [5] notes that "Complex systems are anything but mathematically precise". Many productivity and efficiency methods and measurements (e.g. DRG, NordDRG, FullDRG, ACG, APG, DEA, Monte Carlo DEA, and MOO) have been developed and proposed for social and health care [6-12]. Pritchard et al. [13] complain that the potentiality of the Productivity Measurement and Enhancement System (ProMES) intervention for the effectiveness of organizations and teams is not utilized, mainly because "people are working in jobs that severely limit what they can contribute." ProMES is an intervention for enhancing the productivity of work units within organizations through performance measurement and feedback. The methods and measures of productivity and efficiency mentioned above are beyond the scope this paper.

Innovations in productivity and efficiency generated in manufacturing enterprises and processes are not easily transferable to the most growing area of economics – the service sector. By nature, social and health care service processes are intangible, inseparable, variable, heterogeneous and perishable [14]. Service processes are not "products" per se, tangible in the manufacturing term, but intangible. Intangibility means that the quality of the processes is evaluated by patients´ and customers´ emotions, perceptions, feelings, and expectations. The producing and consuming of care processes happen at the same time; in that sense, they are inseparable. The health and social care processes are very seldom standardized; a lot of variations and heterogeneity exists. The attitude of artistic craftsmanship still prevails in social and health care. The perishability of social and health care means that they are not storable into inventories. Unwillingness to apply the successful methods of manufacturing enterprises have left a lot of opportunities unseized in social and health care.

In 2003, more than two trillion dollars, about 30 percent of the care resources, were lost yearly in the United States due to the costs of poor quality care (overuse, underuse and misuse of resources) that did not provide value for the patient [15]. George [16] states that "the case studies demonstrate how Lean Six Sigma can be used in service organizations just as effectively as in manufacturing – and with even faster results." George continues that empirical data has revealed that the costs of services were inflated by 30-80 percent of waste. He emphasizes that the service processes are full of non-value activities for the customers. He underlines that the service processes are notoriously slow because far too many service processes are unnecessarily complicated and usually in a state of "work-in-process" (WIP), i.e. unfinished. He adds that most service processes are "un-Lean," they have process cycle efficiency of under ten percent. Based on his analyses, George points out that the efficiency requirements of service processes insist on reducing WIP, which is the only way to control the lead time of the process. He emphasizes the Lean lesson that every service process should operate on the pull principle to eliminate variation in lead

time, as only 20 percent of the activities cause 80 percent of the delay.

It is widely accepted that social and health care services in Finland and in Europe are relatively unproductive, inefficient and cost-inefficient (e.g. [8]). The Lean philosophy and methodology, which focuses on removing wastes from systems, was developed in the Toyota Production System (TPS) to make work processes more productive and efficient. "TPS is a way to improve healthcare delivery systems by reducing waste and improving quality" [17]. Already in the 1990s, hospitals in Seattle, USA applied the tenets of the TPS and Lean. The hospitals perceived that the measured performance rates were improved and impressive cost savings were achieved [18]. In social and health care facilities in Finland, there is an increasing number of practical applications of the philosophy and methodology of Lean [19] and the concept of the agile enterprise [4].

The theory of constraints (TOC), developed by Goldratt and Cox [20,21] is the opposite strategy to focusing on cutting costs only. TOC underlines the throughput of the whole organization and its processes, not only decreasing the incurring costs. In a similar way as the Lean methodology prefers flow efficiency to resource efficiency [19], TOC stresses smooth flow of the throughput of the system and processes. "TOC advocates a throughput world, which means that management should focus first on the firm's throughput, then on its inventory and finally on its operating expenses. In TOC, the throughput world is the opposite of the cost world. In the cost world, management puts operating expenses first" [22]. Aligning with Finnish government's overall strategy and goal to increase the productivity and efficiency of Finnish organizations by existing resources, the theory of constraints and five-focusing step (5FS) may be assets in the contemporary, challenging social and health care situation.

A literature search with the terms "productivity and mental, and addiction care" from databases revealed that the productivity decline has been studied mainly in individual psychiatric or somatic diseases [23] or the effect of these on working places (e.g. [24]). Ren et al. [25] state that "TOC five-step focusing process has not previously been applied in healthcare settings," when they did it in their surgical process. They mention the application of TOC for neurosurgery and eyes. To our knowledge, a similar application of TOC and 5FS in integrated mental and addiction care and multi-professional team does not exist.

This paper presents a case study of rethinking the productivity and efficiency in social and health care at the multidisciplinary team level, and at the unit level. Plainly, productivity is the ratio of outputs to inputs, and at the conceptual level, the productivity of health care differs little from other industries or sectors [11]. The focus of this paper is improving the productivity and efficiency of a multi-professional team in an integrated mental and addiction care outpatient clinic (MTPA-model) by the theory of constraints and its methodology, the five-focusing step. The productivity and efficiency application case of the theory of constraints and five-focusing step was the adult ADHD diagnostics process, which is one of the key processes of the outpatient clinic MTPA.

The theory of constraints and the five-focusing step method applied for the adult ADHD diagnostic process of the outpatient clinic

The first author of the paper had to establish a newly and differently designed outpatient clinic in two months at the end of 2010 [26]. The clinic integrates the care of mental health and addiction patients, with direct access to assessment and treatment without referrals in a 7/24/365 manner. The integrated mental health and addiction clinic (MTPA-model) was opened in the beginning of November 2010. The designed integrated mental health and addiction care model, a 24/7/365 walk-in clinic is responsible for the care of 130 000 inhabitants in southeast Finland. The "extended" MTPA-model includes two inpatient departments (14 beds and 13 beds), located near each other in the same building, which enables smooth and efficient face-offs between the integrated outpatient facilities and the inpatient departments. The redesigned inpatient services do not have waiting lists, either.

The MTPA-model is one of the service units of the South Karelia District of Social and Health Services (Eksote). Eksote is as an integrated social and health care enterprise, a forerunner in the development of health and social care services in Finland, as it combines primary and secondary health care, elderly care and social care in an entirely new way, covering nine municipalities that were earlier working independently. The South Karelia District of Social and Health Services is tax-funded, mainly free for the patient, with a yearly budget of ca 430 m€, with about 30 m€ for mental and addiction care. It has about 4 100 employees, of which about 350 in mental and health care. About 30 employees work in the MTPA-model. Eksote operates in a geographical area of over 5 600 square kilometers.

At the end of 2010 in the case study setting, the redesigned walk-in outpatient clinic faced a new challenge: a new patient group emerged, adult ADHD patients, for whom there were no clinical procedures or guidelines for diagnosing and treating them in the clinic. The nearest place to diagnose and treat them was in Helsinki, about 230 kilometers away. According to epidemic studies, 2-5 percent of the adult population would be affected by adult ADHD [27]. According to Statistics Finland, there were 83 000 adults aged 18-65 years in South Karelia in 2011, of which the approximated share of adult ADHD patients was 1 600-4 100 people. It would be impossible to send them with referrals to the tertiary level university clinic for diagnostic purposes. Thus, we generated a CDSS to assist in the adult ADHD diagnostic process [28]. The purpose of the clinical decision support system was to implement a new diagnostic process in an efficiently and procedurally readily adopted way. The actors and tools in the adult ADHD process is presented in Figure 1.

The CDSSs (adult ADHD, working ability assessment of psychiatric patients, and opioid substitution) were developed in focus groups, assisted by external consultants working as facilitators. The outcomes of the focus groups were the developed CDSSs as design artifacts.

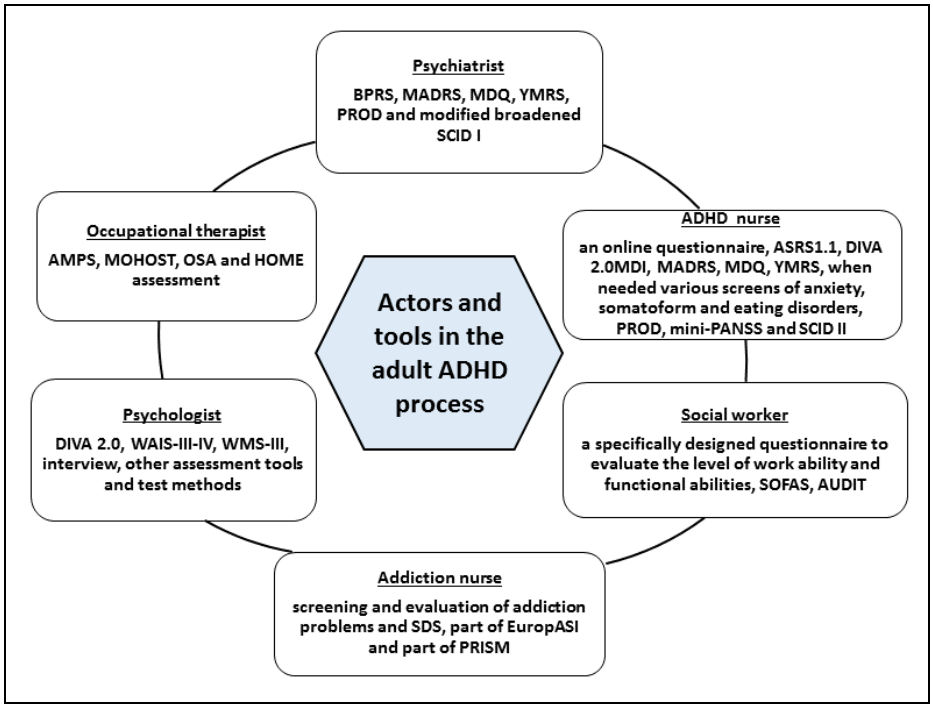

Figure 1. Actors and tools in the adult ADHD process.

We used the action research approach [29] to improve the CDSS-assisted adult ADHD process with TOC and 5FS in 2014-2015. The action research approach was chosen because it was "participating, actionable and studying real problems in ordinary and specific working environment" [30] for the newly established clinic. The action research approach was intertwined with design science research [31] to create the design artifacts, the clinical decision support systems, CDSSs, which was one of the outcomes of the study.

The CDSSs were selected to facilitate fast and efficient training of the employees in the care of mental health and addiction patients. The traditional education methods for learning new things (for example lectures of experts on adult ADHD) were rejected because of the obvious inefficiency of these methods. The known learning curve results say that new things are learned at 5 percent by lecturing, 75 percent by doing and 95 percent by teaching one-to-one [32]. The knowledge base of the adult ADHD CDSS developed as a joint team effort (so as to induce ownership of the change among the members of the multi-professional team). It helped to take advantage of the earlier skills and assets of the psychiatric and addiction nurses, physicians, psychologists, and occupational therapists.

According to Castillo et al. [33], "CDSSs provide enhanced communication across multiple disciplines, improved accessibility to references on best practice, improved adherence to care guidelines, and a more consistent quality of patient care resulting in better patient outcomes. A CDSS alerts and reminders support and encourage continuous learning for nurses at the novice level and reinforce already known knowledge in nurses who are experts. The prompt delivery of care options to the users aids in expediting the decision-making process regarding patient care."

IT-solutions (software design) in developing processes and teams are supported by the governance of the setting. The South Karelia District of Social and Health Services has already been a forerunner in developing IT-solutions in health care, for example an IT-system for the Assess-Qualify-Place process, which is unique in Finland [34].

TOC approaches organizations as systems, and maintains that every system has at least one constraint, in a similar way as a chain has several links, but only one is the weakest link, the bottleneck, the constraint. Identifying, exploiting, subordinating, and elevating that bottleneck or constraint, the 5FS among other system improvement methods yields more productivity and efficiency. Dettmer [5] states that TOC is a prescriptive theory (it explains why and offers guidance for what to do). TOC can also suggest when and how to employ it or a traditional continuous improvement tool (e.g. Lean, Six Sigma) on the current and sometimes a future system constraint.

TOC views systems and processes in a series of dependent events. It likens systems to chains [5]. As the chain analogy maintains that the chain is only as strong as its weakest link ("bottleneck," "constraint"), TOC provides insight into process improvement efforts by focusing on the constraint (the root cause of the problem), not just picking random or "low hanging" fruits [6]. According to Dettmer [5], a simple production system that uses raw materials runs them through five components (A, B, C, D, and E) of processes, and turns them into finished products. Each process constitutes a link in the production chain. The goal of the system is to make as much money as possible from the sale of the products. Each one of the component processes has a daily capacity (A= 10 units/day, B= 20 units/day, C= 6 units/day, D= 8 units/day, E= 9 units/days and output/market demand= 15 units/day). Clearly, in this production system, C is the constraint.

In a similar way, in the CDSS-assisted adult ADHD process, each employee in the multi-professional team and a member of it is considered as a component process that has a daily capacity. The daily capacity was measured from our electronic health record (Effica) with the designed software (a CDSS-assisted adult ADHD process, developed by a private enterprise, Chainalytics) at the beginning of the improvement effort and the end of the development effort in 2011-2015.

Based on previous examples and experiences described in the literature, a 5FS-experiment was conducted in the CDSS-assisted adult ADHD process. In 5FS, the pri-

mary purpose of improving processes is to identify and manage the system constraints (more informally the bottlenecks of the system). As the name 5FS denotes, it consists of five different phases [5,20]:

1) Identify the system constraint(s) means identifying the resource which limits the throughput (and at the same time the lead time) of the entire system, e.g. a long queue of work or long processing time.
2) Decide how to exploit the system constraint(s) means deciding how to modify or redesign the task of the constraint, e.g. the constrained work will be performed more effectively and efficiently.
3) Subordinate all else to the constraint(s) of the system means directing all the efforts to improve the performance of the constraining resources.
4) Elevate the constraint(s) of the system means adding capacity that will increase (elevate) the overall throughput of the constraint.
5) If in previous step 4 a constraint is broken, go to step 1, but do not allow inertia to cause a system constraint, means keeping the improvement of the implemented process going, i.e. continuing from step 1 again.

Our goal was to improve the CDSS-assisted adult ADHD process according to TOC and 5FS. The aim was to decrease the throughput, and the lead time, and abolish unnecessary delays, and if possible, also reduce operating expenses. To sum up, to be an efficient adult ADHD process of continuous improvement, it must consider the three fundamental TOC-questions: 1) What to change? Pinpoint the core problems, which have the major impact, once corrected, 2) What to change to? Construct simple, practical solutions, and 3) How to cause the change? Induce the appropriate people to invent such solutions.

Goldratt et al. [20] elaborated the idea of these questions to the Logical Thinking Process, which consists of six distinct logical trees and the "rules of logic" that guide their construction. For the first question, there is the Current Reality Tree (CRT), for the second the Future Reality Tree (FRT), and for the third the Prerequisite Tree (PRT). The presentation of the Thinking Process is beyond the area of this paper.

In our research, the goal was to provide the adult ADHD patients with 1) the minimum possible throughput, the lowest lead-time in the process, 2) absence of waiting lists, work-in-process (WIP) and unnecessary delays, and 3) the minimum possible expenses, costs and employees involved in the process. The research questions were: 1) Will the lead time of the ADHD process decrease and the amount of diagnosed adult ADHD patients increase by TOC and 5FS-intervention in 2011-2015, 2) Will the waiting lists, WIP and unnecessary delays disappear, and 3) Will the personnel resources involved diminish in the monitoring period 2011-2015?

Results from applying TOC and 5FS to the CDSS-assisted adult ADHD process

A solution to an apparent process problem of the adult ADHD process was to construct a straightforward and practical solution - a CDSS for adult ADHD patients. The developed CDSS (a designed software to be added to the currently used electronic health record Effica) aimed at guaranteeing the quality and standardized care of the new patients. The MTPA-model has proven its overall efficiency and effectiveness concerning access to services and improved quality of care [35]. The accuracy of diagnoses of multi-diagnostic adult ADHD patients and at the same time an effective implementation of the new, inexperienced multi-team member protocol of assessment of those patients was ensured by the CDSS.

The old adult ADHD process [28] developed for the new patient group faced at the MTPA is presented in Figure 2.

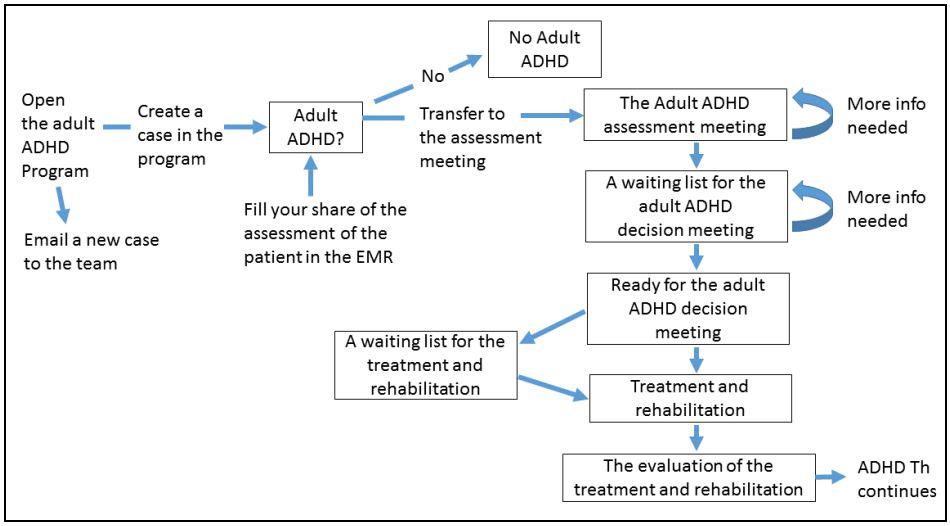

Figure 2. The old adult ADHD process.

The new adult ADHD process was iterated according to the TOC principles. The first principle is "identify the constraints". There are three different kinds of constraints in a process or system: 1) physical, 2) policy and 3) paradigm constraints [5, 36]. In October 2010, the statistics of Effica (EHR) revealed that an average employee of the MTPA-model had 2.4 direct patient visits per day. At the same time, the employees alleged that they did not have open appointment times for future patients.

The new TOC-framework of the adult ADHD process focused on the physical constraint, which turned out from the time labels of the different employees using the EHR and the adult ADHD clinical decision support system. The results revealed that the psychologists and the occupational therapists had on average two patients per day. These were the physically constrained resources allocated for the everyday tasks of these specialized employees in our organization.

At the beginning of the CDSS-assisted adult ADHD process we concluded that we aimed at the ideal process in the "first time right" –principle [37, 38, 39]. Efficient assessment would be done accurately and thoroughly. After applying the TOC and 5FS-principles, it had to be decided how to exploit the psychologist and occupational therapist constraints. The diagnosis of an adult ADHD patient did not necessitate the evaluation of an occupational therapist, but it helped the staff after the completed assessment in selecting the right treatment and rehabilitation of the patient. The evaluation of the psychologist was not necessary either in a strict diagnostic sense, but it explained the core difficulties of the adult ADHD patient better than the other employees of the multi-professional team could do.

Subordinating all the psychologists to improve the constraining resources could have been done, but it would have needed extra training in evaluating the adult ADHD patients. The evaluation process was new, and the experience of the evaluation of these adult ADHD patients would cumulate only by conducting the assessments. We decided to broaden the knowledge of the psychologists who were conducting the assessments. We composed targeted neuropsychology training from the top neuropsychologists in Finland. Every psychologist will be able to carry out adult ADHD assessment in the future. With the time labels of the adult ADHD CDSS, monitoring the constraints of the adult ADHD process were possible (resembling a visual Kanban), and necessary decisions to transfer more re-

sources to the process from the other daily chores of the psychologists were done.

To elevate the constraints of the adult ADHD process, the part of the occupational therapist was mainly excluded from the beginning of the evaluation process, and on those occasions when it was needed, it was done later when we were deciding on the rehabilitation options.

The principles of the 5FS of the theory of constraints applied to the adult ADHD process helped us focus our efforts on the limiting issues of the capacity and capability of our other processes. When a regular time constraint complaint of an employee in the organization was met, illustrating the adult ADHD process and its constraints with pictures helped to negotiate constructively with the employees about further steps to solve the constraint issues. Solving the problems of the process by process thinking was proactive, not as the reactive case would usually be, accusing openly or indirectly the slowest employee of the difficulties of the process. The latter type of behavior is quite common in functionally thinking organizations.

With the critical supply chain model (Figure 3) the employees who were unfamiliar with process thinking, could understand and apply the principles of TOC. It helped to find a constructive joint solution to the constraint problems of the adult ADHD process.

The productivity of the CDSS-assisted adult ADHD process increased from 2.6 direct patient visits per day to 4.6 visits per day. The productivity and efficiency of the CDSS-assisted adult ADHD-process rose in throughput. In the MTPA-model, the average was 4.6 direct patient visits per day per employee already in 2012. The trend continued to the end of 2015. 125 adult ADHD patients were recruited in the process in the period 30 November 2011 - 30 September 2015. The clinical decisions concerning the consultation of the occupational therapist and the psychologists sharpened, which saved about four appointment hours per patient. The software layout worked as an electronic Kanban-card (see [40]), which showed the flow of the patient.

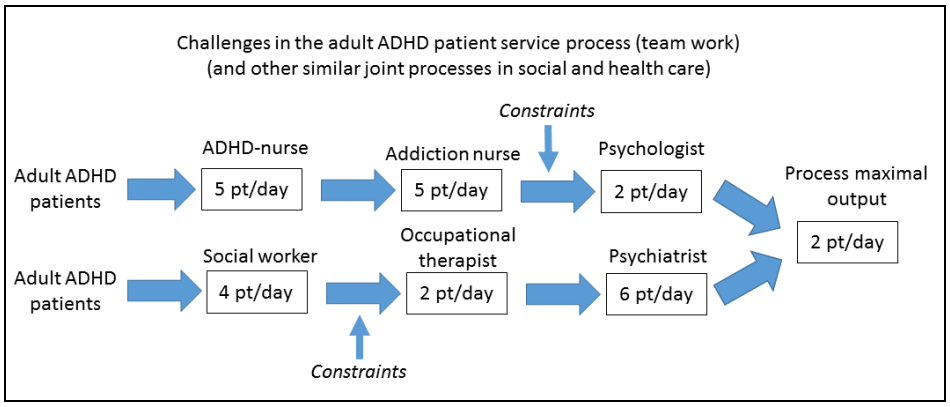

Figure 3. Critical supply chain model of the adult ADHD patient service process.

The waiting list problem did not emerge (we did not have "inventories"). Internal inefficiency and delays did appear, partly because of vendor-lock-in problems. The designed CDSS-software needed an interface integration to the electric health record system (EHR, Effica) to avoid double effort in writing down the findings of the adult ADHD process. The planned monitoring of the lead time did not work because the interface difficulties between the software and the EHR were not resolved. The employees wrote the patient information to the CDSS in batches, when they had extra time to do it, which destroyed the use of the time labels in evaluating the exact lead time. We decided to stop doing double work in writing the same information to both IT-systems. We started to wait for the missing ensemble solution between the EHR and the adult ADHD CDSS. The interface problem still prevailed in December 2016.

The operating expenses did not increase in 2011-2015. No other employees were allocated the adult ADHD process. Some assessment efforts for the adult ADHD patients by other psychologists in the MTPA-model were done. In Germany, Stierlin et al. [41] have evaluated integrated mental health care programs, and the authors maintain that the deinstitutionalization of mental health patients did not cut the expenses, but that was not the case in our extended MTPA-model. The resources to redesign or reengineer the integrated mental and health care were gained from the existing resources by closing two of the four inpatient wards. In the South Karelia District of Social and Health Services, the budget savings of the whole integrated mental and addiction care in 2011-2015 were about six million euros (the yearly budget was about 30 million). In redesigning/reengineering the mental and addiction care services (especially the MTPA-model), budget savings were not the primary focus of improving care, but a successful "side-effect." Although we had already saved a lot of money, after adopting the continuous improvement mindset, we tried to make additional improvements in MTPA with TOC and 5FS.

Finally, it was easy to reveal the difficulties in the service production of the integrated mental and health care organization, when the theory of constraints and five-focusing step were applied to the processes of the MTPA-model. The efforts of removing the constraints were a joint enterprise with the action research approach [29], where the inventor emotion and the credits were allocated to the whole team [21]. The theory of constraints offered a shared vision to facing the shop floor process problems of the integrated mental health and addiction care in general. Negotiations of the occasionally changing daily duty responsibilities of the employees were easier when the big picture of the operating principles were understood by every employee.

Discussion and conclusions

Over 60 percent of taxpayers' money is already spent in social and health care in Finland. Claiming for more resources to operate in social and health care is not an option in the current economic operational environment. The abundant resources should be allocated in a new and innovative way to achieve better results with the same resources. The operational implementation of the strategy is managed poorly in social and health care. According to the Ministry of Finance of Finland, at least 20 percent of resources of health care is wasted [42]. This 20 percent would mean savings of about three billion euros in social and health care [43].

A commonly held belief in mental health and social care is that the care for patients must be offered by multi-professional community mental health teams [41]. In Finland, the newly given law of social care [44] points out the importance of multi-professional assessment of social care clients. The assumption is that the complex situations and cases in social and health care need the expertise of different specialists, which is underlined and secured by the law. The real intention of legislators may quickly exacerbate the resource problem caused by focusing only on resource efficiency, not on flow efficiency (e.g. [19]). The multi-professional teams may misplace and drain the resources from the smooth and flowing operation of social and health care.

An inevitable consequence of the claim for multi-professional teams is having a lot of gatherings and meetings. The limited capacity of the social and health care personnel is already lost in the current inefficient

practice, which includes abundant and ineffective meetings. Nelson et al. [45] state that over 50 percent of all the time spent in meetings is unproductive, worthless, and of little consequence. This teamwork structure without proper consideration of the flow efficiency plunders a lion's share of the capacity of social and health care operations.

As Vissers et al. [46] state, specialist time is the most essential bottleneck resource in a hospital. The specialist time for patient groups is the most important element in the production planning process. The results of this case study indicated that applying the theory of constraints and five-focusing step to planning and scheduling, the specialist time is a viable and efficient way to improve the productivity and efficiency of an integrated mental health and addiction care services organization.

Gupta et al. [47] point the process output and constraints as markers for the achievement of the organization: "The rate of output of the whole system determines the rate at which the purpose (the goal) of the organization is accomplished. Theory of constraints further defines a constraint as anything that limits an organization's higher performance in terms of its goal".

For successful implementation of the TOC and 5FS, the goal and the system view of the organization are a necessity. Traditionally, health care facilities are organized by increasing specialization and independent functions, which in many cases generate problems of sub-optimization and diminish joint enterprises, due to rivaling for the same resources in the zero-sum game. The theory of constraints allocates the resources where they are needed, not by whose they are. The principalities of departments must become extinct and give way to the process organization. In the developing of the whole integrated mental and addiction care, the MTPA-model matured in process thinking far ahead of the other units. Goldratt [21] warns about implementation problems: what happens if one department of the whole organization is ahead of the others, and if innovators do not identify the psychology of the organization, and if the top heads will not buy the solution?

Shortly, Goldratt [21] explains about managing and change that every manager is overwhelmed with problems, which could also be called opportunities. Any improvement in an organization is impossible without change, and any change is perceived as a threat to security. The unavoidable consequence of every change in an organization is emotional resistance, which stems from insecurity, which is provoked by the change. Goldratt reminds that emotional resistance could be overcome only by a stronger emotion. When people are resisting change by emotions, they are not listening to logical evidence, no matter how solid these are. "The proof is in the pudding, and the puddings are not always the same," Goldratt condenses the issue. The solution offered by Goldratt is the Socratic Method. He stresses that if a person is directly supplied with answers, he/she is blocked once and for all from inventing those same answers him/herself. For the employees to be able to own the problems faced by the manager, they should be induced by someone to invent a solution for a problem. By creating the solution for a problem by themselves, they are much eager to own it and not answer with the typical answers about changing things: it is not my problem, I have not caused it, and we are different, it would not work here. By owning the solution for their problem, they might have a stronger emotion than emotional resistance and the change would be possible. As a future research effort, the TOC and 5FS could apply to the other social and health care service enterprises.

In social and health care, there are many advocates in the name of clients and patients, even if we do not have a real voice of the customer (VOC). We have not adequately surveyed from the perspective of the clients and patients of social and health care how the services should be organized. The view of the employees and managers of social and health care dominate the service organizing principles. The patients and clients, as well as the shop floor employees, may have valuable insights into making the services more appropriate, efficient, effective, and productive. We do not have the VOC of the adult ADHD patients at all. In reality, we do not have a measure of the effectiveness of the adult ADHD-process (e.g. [48]).

The theory of constraints and 5FS provide a general and easily understandable framework for improving the productivity and efficiency of the organization. The productivity measurements - throughput, Inventory and operating expenses – are easy to reflect and can help to focus on the right measurements at the system level. The TOC and 5FS constitute a common and fruitful tool for the whole organization to face the inevitable changes in the social and health care environment.

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