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Perspectives of Mass Customisation and Modularisation in Health Service Delivery: A Scoping Review

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Abstract

Background: Mass customisation and modularisation are considered means to enhance patient-centredness and control increasing healthcare expenditures. **Purpose:** The purpose of this study is to identify existing knowledge regarding the application of mass customisation and modularisation in healthcare delivery while focusing specifically on outcomes. **Methods:** A scoping review was conducted with various combinations of search terms using Scopus. Nearly 2000 studies were identified of which 18 met inclusion criteria. Patient experience, customisation, and the economic impact on service delivery was analysed. **Results:** Mass customisation and modularisation may be applicable in healthcare. The model may increase patient satisfaction. However, more knowledge of the outcomes of mass customisation is needed. As the number of studies in this area is limited, more empirical mixed methods research on the implementation and outcomes of mass customisation is needed to understand the expected benefits and to determine the possible effects on patient satisfaction and financial implications.

Keywords: mass customisation, modularisation, healthcare, health services, customisation, personalisation, services, scoping review

1. Background

Tailoring services to meet individual needs and to increase patient-centredness has become an important target in the healthcare field. Simultaneously, healthcare faces universal problems such as cost inflation, increasing demand, ageing populations, and the existence of both over- and under-treatment. There is a need to improve the care experience of patients and the overall

health of the population while reducing healthcare costs (Berwick et al., 2008). Traditionally, healthcare services have been characterised as individually customised craftsmanship services (Bohmer, 2005; McLaughlin and Kaluzny, 2000). In recent decades, healthcare services have evolved towards mass production and mass customisation (McLaughlin and Kaluzny, 2000). In other words, healthcare is not only moving from mass production towards customisation, but also from craft (highly customised/ tailored) towards a certain level of standardisation and mass customisation. Thus, standardisation of services may take place during mass customisation and modularisation (Silander et al., 2017).

Mass customisation and modularisation are concepts derived from operations management (Baldwin and Clark, 1997; Pine, 1992). The two concepts are closely related, and modularisation has been considered a means to achieve mass customisation (Duray et al., 2000; Pine, 1992). In healthcare, the two models have been considered possible ways to tackle the problem of increasing customisation and variety, while benefiting from the advantages of mass production and standardisation (Berwick, 1997; Bohmer, 2005; McLaughlin and Kaluzny, 2000; Meyer et al., 2007). However, although mass customisation and modularisation have been studied since the 1990's, no single clear definition exists for either concept. Mass customisation has often been defined as “developing, producing, marketing, and delivering affordable goods and services with enough variety and customisation that nearly everyone finds exactly what they want” (Pine, 1992, p.44) and modularisation as “building a complex product or process from smaller subsystems that can be designed independently yet function together as a whole” (Baldwin and Clark, 1997, p.84).

The mass customisation of services can shift services from either mass production towards customisation or from customisation towards standardisation (Heiskala et al., 2005). Thus, the benefits of mass customisation vary (Heiskala et al., 2005). In service fields, moving from mass produced services towards mass customisation has been suggested to bring benefits such as

facilitating accurate customer information, increasing customer satisfaction through customer involvement, and supporting the fulfilment of customer needs (Heiskala et al., 2005). When moving from full customisation towards mass customisation, benefits such as improved efficiency, consistent quality, and lower costs have been suggested (Heiskala et al., 2005; Svensson and Barfod, 2002). Mass customisation may involve the use of different principles from other operations management models such as 'lean and agile', and these principles have been suggested to be relevant in the implementation of mass customisation (Fogliatto et al., 2012). Mass customisation and modularisation have been successfully implemented in areas such as the bicycle manufacturing industry (Kotha, 1995), the fashion industry (Pekkarinen and Ulkuniemi, 2008), cruise services (Voss and Hsuan, 2009) and healthcare (Bohmer, 2005; Meyer et al., 2007; Silander et al., 2017).

The processes involved in mass customising and modularising services differ between different service fields and organisations. This is evident in healthcare. As service production between healthcare service fields and organisations differ, mass customisation and modularisation may be applied variably in different contexts. Modularisation has been applied to fields such as mental health services (Soffers et al., 2014; Weisz et al., 2012), elderly care (de Blok et al., 2010a, 2010b), and hospital care (Silander et al., 2017), and in all cases the process and appearance of modularisation differ. In the healthcare context, an organisation engaged in mass customisation has been described as "an organisation [that] gathers information about what individual patients need or prefer and then customises services to match these preferences" (Thompson and Nussbaum, 2000). When mass customising healthcare, there is a need to understand what patients want and value (Minvielle et al., 2014; Thompson and Nussbaum, 2000), how to integrate information technologies and the workforce to re-engineer care processes (Minvielle et al., 2014), and how to balance the perspective of one patient versus the

whole population (Minvielle et al., 2014). Additionally, it has been argued that in healthcare modularisation is required to enable mass customisation (McLaughlin and Kaluzny, 2000).

Clinical pathways are an example of modularity from a medical perspective and choosing the right pathway for a patient can be regarded as mass customisation (McLaughlin and Kaluzny, 2000). From an operational perspective, the specialties or operating units of a healthcare service provider such as an outpatient clinic or hospital ward can be considered as modules. The decomposition of services into different modules may vary depending on the level chosen (Voss and Hsuan, 2009). As an example, in hospitals modules can be different specialties, functions, or units such as wards or outpatient clinics (Silander et al., 2017).

In healthcare, mass customisation and modularity are suggested to have potential benefits such as enabling efficient health services and improving patient-centredness as they promise customised services for patients by flexibly combining standardised and mass-produced components and modules (Berwick, 1997; Bohmer, 2005; McLaughlin and Kaluzny, 2000; Meyer et al., 2007). However, although both mass customisation and modularisation are discussed in healthcare management, no comprehensive knowledge exists on the implementation and outcomes of these concepts. Thus, further knowledge of the applicability of these concepts is needed to support their implementation.

1.1 Framework

Two key elements of mass customisation are the segmentation of customers and modularisation. The identification and grouping of customer needs and customer segments are essential in mass customisation, because customer needs may vary across demographic groups (Wei Yan et al., 2007). Modularity is the basis of repetitiveness in mass customisation, as

creating repeatable service modules as well as mixing and matching these modules according to service needs creates customisation and variety while limiting costs (Duray et al., 2000; Schilling, 2000).

Various frameworks that conceptualise mass customisation have been published (Duray et al., 2000; Lampel and Mintzberg, 1996; Tseng and Piller, 2003). In a framework developed by Tseng and Piller (2003), mass customisation is divided into four levels: (i) differentiation, (ii) cost, (iii) relationship, and (iv) solution space. The first three levels focus on customer-centredness and the outcomes of mass customisation. The differentiation level involves the fulfilment of clients' needs through the customisation of services (Tseng and Piller, 2003). The cost level focuses on the costs of mass customisation, and the relationship level addresses the relationship between the service provider and the customer (Tseng and Piller, 2003). In the fourth level, the solution space level, the focus is on capabilities and actions related to the mass customisation of an organisation. Identifying relevant customer aspects, such as needs, preferences, and desires, is the core requirement of this level (Piller and Blazek, 2014). Modularity is linked to this level of the framework, as it enables the achievement of robust processes (Piller and Blazek, 2014).

Mass customisation and modularity have been discussed in healthcare management, but there exists little evidence of the applicability and use of these concepts in health services. This scoping study aims to explore and identify mass customisation and modularisation studies on health service delivery and aims to describe how the outcomes of these concepts have been studied in health services.

2. Methods

A scoping review is used to identify and analyse relevant literature in a specific research field (Arksey and O'Malley, 2005). It is often used when studies use a wide range of data sources

and varying study designs to analyse the extent and range of research activity of a specific topic and identify gaps in research evidence (Arksey and O'Malley, 2005). In this study, a scoping approach was applied to identify publications in health service mass customisation and modularisation, with a focus on service delivery and outcomes. The different stages of this study were conducted in a rigorous and transparent manner and are similar to checklist items described in the PRISMA guide (Arksey and O'Malley, 2005; Moher et al., 2009).

2.1 Research questions

The following scoping research questions were formulated: (1) In which major literature streams and journals has healthcare delivery mass customisation and modularisation research been published? (2) Which research designs and what types of data were used in the eligible studies? (3) How have the outcomes of mass customisation and modularisation been studied, and what are the effects of modularisation and mass customisation?

2.2 The identification of relevant studies

First, Medline was searched for appropriate MeSH terms in healthcare management, but no relevant MeSH terms were identified, which is in line with previous studies (Mahdavi et al., 2013). Because this research field is still evolving and has not yet been fully established, we included a broad spectrum and various combinations of search terms to maximise sensitivity. Additionally, the terms and their combinations were discussed with an experienced healthcare management researcher who was not part of the research team.

The terms *mass customisation*, *mass personalisation*, *service personification*, *service modularisation*, *modular services*, *service modularity*, *agile production*, *total quality management*, *service design*, *customer focus*, and *healthcare integration* were combined with each other and with terms such as *healthcare*, *health*, *care*, *patient process*, *health process*,

medical process, health sector, health service, healthcare service, healthcare management, patient-centred care, care pathway and patient-level integration (see Additional File 1: Search Strategy). The terms focused on the delivery (i.e. operational management perspective) of healthcare.

The Scopus database was chosen, because it contains all the journals indexed in Medline and has been recommended for studies on operations research, management science, and healthcare topics (Jahangirian et al., 2011). The searches were conducted individually by two researchers (KS, AS) using Scopus advanced search field, title–abstract–key words (TITLE-ABS-KEY), with no additional filters. The results of both researchers were compared to ensure the reproducibility of searches.

2.3 Study selection

Study selection was performed in a systematic manner (Figure 1), and a screening protocol with inclusion and exclusion criteria was developed (Table 1). To increase reliability, two authors (KS, AS) selected the studies. Both independently reviewed the title and abstract of each identified study and determined which studies would be included in the next step. The studies were directly included or excluded if both reviewers independently agreed. If a study was in doubt or disagreed upon, the study was included. The researchers decided to include only studies published in English in peer-reviewed international journals. If studies were published in open-access journals, then a documented peer-review process was required.

The reference lists of the studies included in the preliminary step were manually searched and the authors of the included studies were listed. Two independent search methods were used for the reference lists and authors: (i) author snowballing and (ii) reference snowballing. In the author snowballing method, the publications of authors with two or more studies ($n = 10$) within the included studies were identified and then analysed according to the study selection

process. In the reference snowballing method, the references of the included studies were first scanned by one author (KS) and then analysed by two authors (KS, AS); this was the final search strategy in the study selection process. Studies identified through the final electronic search and snowballing methods were read by two authors (KS, AS), and the studies' inclusion or exclusion was validated by a third author (MK) based on the same previously described inclusion and exclusion criteria.

[Insert Table 1]

[Insert Figure 1]

2.4 Charting and analysing the data

Basic information (i.e. title, authors, journal, publication year, and keywords) was recorded as well as the aim, methods, and data. The country in which the study was conducted, and the results or findings were extracted. The design, study setting (i.e. health services, social and health services, elderly care, or home care), and type of informant (i.e. patient, healthcare professional, or other) were identified and categorised. Data on the methods used (i.e. patient interviews or surveys, personnel interviews or surveys, or other sources of information) were extracted. Related words for segmentation, modularisation, customisation, and mass customisation were identified.

Tseng and Piller's framework (2003) was modified, and then used to analyse the data. The analysis was based on a) the organisational level (i.e. solution space level) by categorising studies into three groups: patient segmentation, service modularisation, and mass customisation and b) three outcome dimensions derived from Tseng and Piller's (2003) framework. The

customisation dimension involves how the customisation of services enables fulfilment of patients' various needs. The economic impact dimension takes into account how mass customisation affects the cost of services, and the patient experience dimension includes experiences that patients have had with customised services.

The journals, in which the studies were published, were grouped into four categories: management, healthcare management, medical, and medical and healthcare management, according to the ISI citation report (*ISI Web of Knowledge, Journal Citation Reports®*, 2015). When the journal was not listed in the ISI, it was categorised by reviewers according to other information available about the journal (n = 3).

2.5 Limitations of search methodology

We aimed to use a comprehensive search strategy by including a wide range of search terms and combinations. Similarly, references and authors were identified to ensure the inclusion of all relevant studies. However, it is possible that we have not identified all the relevant studies, due to the wide range of journals and lack of standard terminology. We did not include the term “segmentation” in the search terms, as it is not exclusive to mass customisation or modularity. If the terms “mass customisation” or “modularity” were not used in studies on segmentation, we may have missed these studies.

3. Results

Figure 1 demonstrates the results of the study selection process. A total of 1847 records were identified after the exclusion of duplicates (Figure 1). After study selection and screening, 18 studies were included in the qualitative analysis (Table 2). Thirteen studies were identified through searches in Scopus and one was identified from other sources; the author snowballing

method yielded two studies, and reference snowballing identified two additional studies (Table 2). Six of the 18 studies were published in management journals, seven in healthcare management journals, and two in medical journals. Three studies were published in journals categorised as both medical and healthcare management. Twelve of the 18 studies were published between 2010 and 2014. Words related to segmentation, modularisation, customisation, and mass customisation were identified and categorised (Table 3), demonstrating that terminology has not yet been established in the field.

[Insert Table 2]

[Insert Table 3]

3.1 The organisational level

The studies were categorised as mass customisation, modularisation or segmentation, also data used in the studies were documented (Table 2). Most studies were categorised as mass customisation studies. Of these, two used both patient and personnel perspective data, three studies used only professional data, and one study relied on patient interviews alone. Four studies used neither patient or personnel surveys nor interviews (Table 2). Studies categorised as modularisation used personnel data or literature, no patient perspective data were used (Table 2). Studies categorised as segmentation studies relied on patient perspective data alone.

The studies demonstrate that mass customisation and modularisation may be applied differently in different contexts. Thus, no one universal model to apply modularisation or mass customisation exists. In elderly care, services can be divided into modules in different ways, depending on the focus the organisation has decided upon (see de Blok et al. 2010a, Additional file 1: Supplemental tables). Organisations may focus on the supply side of service production or on the day-to-day life of elderly. Modules can be arranged from a supply perspective including modules such as i) care (including sub-modules e.g. domestic and nursing care, treatment or health), ii) welfare and social support (including e.g. information and advice or accompaniment), and iii) housing (including e.g. cleaning services) (de Blok et al, 2010a). The submodules can similarly contain components (e.g. sub-module domestic care includes components such as mopping, window washing etc.).

However, modules may also be organised and designed from a client perspective, and may include modules and sub-modules such as i) comfort (including e.g. laundry services or pedicure), ii) cosiness (including e.g. social activities), iii) safety (including alarm service or night care), and iv) road to recovery (including e.g. specialist nursing care and physiotherapy) (de Blok et al. 2010a). This demonstrates how the viewpoint of organisations affects the modularisation process.

Van Campen and Woittiez (2003) model the effects of policy decisions in elderly care. Their mass customisation perspective focuses on modelling changes in health service production and patient pathways following policy decisions. This perspective is more theoretical and takes a top-down stance compared to de Blok et al. (2010a). In the study by Meyer et al. (2007), modular platform design was applied through case management to enhance integration of care with complex patient cases. The researchers identified a case management architecture including areas such as i) case screening, identification, and assessment, ii) care management, iii) discharge planning and implementation, and v) utilization review. Thus Meyer et al. (2007) look into service delivery from a more supply side perspective (c.f. de Blok et al. 2010a).

In the study by Fairchild et al. (1998), the focus was to study patient experiences of homeless patients that had been treated in highly customised, moderately customised or standard primary healthcare services. The study looked into the customisation of services in large volumes (mass customisation) to fulfil special needs of a special patient group. Modularisation as such was not clearly applied. Thompson and Nussbaum (2000), on the other hand, focused on the mass customisation of service delivery through understanding

patient preferences regarding the gender of the physician, physician visit times, and group health education. This customisation perspective differs from e.g. those described by de Blok et al. (2010a), and van Campen and Woittiez (2003). Although mass customisation and modularisation are applied differently in the studies, the need to recognise patient needs and patient segments to enable the use of the operating models is clear.

3.2 The three outcome dimensions

3.2.1 Customisation dimension

The customisation dimension is the most prevalent of the outcomes analysed in the studies. The identified studies cover a broad field of various types of healthcare services such as elderly care (de Blok et al., 2014, 2013, 2010b, 2010a; Van Campen and Woittiez, 2003), primary care (Doner Lotenberg et al., 2013; Hogg et al., 1998; Thompson and Nussbaum, 2000), and hospital care (Chaudhuri and Lillrank, 2013; Fairchild et al., 1998), including cancer follow-up (Benning et al., 2012).

In modularised elderly care, continuous needs assessment supports fluent and streamlined information flow between the patient and healthcare provider, and an evaluation process supports the identification of changing needs during care (de Blok et al., 2014). It has also been demonstrated that the standardisation of interfaces enables the production of more customised services to elderly care patients (de Blok et al., 2014, 2013, 2010b, 2010a). In elderly care, organisations enable the further customisation of service packages to meet

individual needs by combining different service components from a list of premeditated choices (de Blok et al., 2013). Meyer et al. (2007) argue that the application of modular platform architecture may support the integration and coordination of different steps and providers, and thus, streamline the flow of information and integration of care.

The use of prediction rules, which relate to future healthcare needs of different patient groups, enhance the fulfilment of patient needs (Fairchild et al., 1998; Van Campen and Woittiez, 2003). Fairchild et al. (1998) reported that the creation of a validated screening instrument incorporated into a hospital's routine admission assessment enhanced the early recognition of individual patients' future healthcare needs. Prediction rules concerning future service needs of different groups of elderly patients have also been successfully demonstrated (Van Campen and Woittiez, 2003).

The clarification of service contents and the required service order, support the identification of patients' frequently required services and align resources to support the delivery of these services (de Blok et al., 2014). The recognition and categorisation of different patient needs support providers in mass customising service delivery, both content- and geographic-wise (Doner Lotenberg et al., 2013; Hogg et al., 1998; Thompson and Nussbaum, 2000). Mass customising information, for example, in the form of customised letters to patients, may support the delivery of preventive healthcare actions in primary healthcare (Hogg et al., 1998).

3.2.2. Economic impact dimension

Only five of the 18 eligible studies approach the economic issues related to mass customisation (Benning et al., 2012; Chaudhuri and Lillrank, 2013; McLaughlin and Kaluzny, 2000; Meyer et al., 2007; Minvielle et al., 2014). Only one of the studies (Benning et al. 2012) included cost data. However, all of the studies have a conceptual or theoretical perspective, none of the studies demonstrated costs reductions or increases. Thus, real empirical evidence of costs reductions or increases is lacking. The studies suggest that mass customised services may have higher utility rates for patients without cost increases to service producers (Benning et al., 2012; McLaughlin and Kaluzny, 2000). They may also improve resource and flow efficiency, and thereby enhance the cost-effectiveness of hospital services (Chaudhuri and Lillrank, 2013). Additionally, the use of a platform design in healthcare services may increase the efficiency of service delivery and lower costs through the improved integration of care and streamlined communication (Meyer et al., 2007).

However, researchers have also noted that mass customisation may increase costs with respect to mass production, as economies of scale may be lost if an organisation moves from mass production towards mass customisation (Minvielle et al., 2014). Mass customised services require investments in e.g. IT systems and staff to enable the handling of complexities related to customisation. On the other hand, customisation of treatment schemes and healthcare delivery may reduce costs in cases in which standardisation of care

is not possible. (Minvielle et al., 2014). Thus, it is not clear whether mass customisation may increase or decrease costs of health service delivery.

3.2.3. Patient experience dimension

Eight of the studies (Benning et al., 2012; de Blok et al., 2013; Doner Lotenberg et al., 2013; Kertesz et al., 2013; McLaughlin and Kaluzny, 2000; Meyer et al., 2007; Minvielle et al., 2014; Thompson and Nussbaum, 2000) relate to the patient experience dimension. Four studies (Benning et al., 2012; Doner Lotenberg et al., 2013; Kertesz et al., 2013; Thompson and Nussbaum, 2000) contain direct surveys or questionnaires. The remaining studies do not include direct input from patients and discuss the patients' perspective from a theoretical viewpoint (McLaughlin and Kaluzny, 2000; Minvielle et al., 2014) or analyse it based on information obtained from healthcare personnel (de Blok et al., 2013; Meyer et al., 2007).

The findings suggest that the mass customisation of primary services may increase patient satisfaction (Kertesz et al., 2013; Thompson and Nussbaum, 2000). Service providers may increase patient satisfaction by responding to patients' preferences related to service availability or professionals (Kertesz et al., 2013; Thompson and Nussbaum, 2000; Benning et al., 2012; Doner Lotenberg et al., 2013). Service access problems decrease patient satisfaction (Kertesz et al., 2013; Thompson and Nussbaum, 2000) and are reportedly higher in mass-produced, non-tailored services, when compared to mass customised services (Kertesz et al., 2013). Thus, by identifying differences in preferences related to access and personnel characteristics, the mass customisation of service delivery may support fulfilling patients' preferences (Kertesz et al., 2013; Thompson and

Nussbaum, 2000). Furthermore, healthcare staff may modify their behaviour when providing mass customised services to patients and thereby enhance the customisation of services to an individual patient (de Blok et al., 2013). Online platforms are also a way to facilitate clear communication between patients and providers (Minvielle et al. 2014). Patients have reported that applying digital platforms to increase information sharing between patient and provider are an interesting new method to customise services (Doner Lotenberg et al., 2013).

4. Discussion

The need to provide customised services while simultaneously cutting costs in healthcare has been identified (Berwick et al., 2008). Mass customisation and modularisation show promise regarding enhancing the customisation of services according to individual needs. Mass customisation and modularisation are closely linked to other operating models and their principles (Fogliatto et al., 2012), and mass customisation and modularisation are arguably useful as production strategies to enhance the development of service production to support 'total quality management' (McLaughlin and Kaluzny, 2000).

The findings of this study demonstrate that the mass customisation of health services may be a way to support the fulfilment of patient needs (de Blok et al., 2014, 2013, 2010b, 2010a; Fairchild et al., 1998; Van Campen and Woittiez, 2003) and increase patient satisfaction (Kertesz et al., 2013; Thompson and Nussbaum, 2000; Benning et al., 2012; Doner Lotenberg et al., 2013), supporting prior findings from other service fields (Heiskala

et al., 2005). However, the findings related to costs vary. Some indicate that mass customisation may improve resource and flow efficiency and thus enhance the cost-effectiveness of services (Chaudhuri and Lillrank, 2013; Meyer et al., 2007) and increase the benefits of services without increasing costs (Benning et al., 2012; McLaughlin and Kaluzny, 2000). On the other hand, researchers have also suggested that mass customisation may increase costs when combined with mass production (Minvielle et al., 2014). However, it is noteworthy that the studies identified in this review did not analyse empirical cost-data. Thus, future studies are needed to gather real-world evidence of cost increases or reductions.

The findings demonstrate that the mass customisation and modularisation of health service delivery has not been fully established as a research topic, as evidenced by the limited number of related studies and the wide range of journals in which studies were published. The findings demonstrate that mass customisation and modularisation may be applied differently in different contexts. Thus, no one universal model to apply modularisation or mass customisation exists. Additionally, no standard terminology of the concepts has been established in literature. Currently, the research area is largely focused on elderly and home care services, and hence, the findings may not be applicable to other healthcare areas. Studies also include more interviews or surveys with personnel members than patient-level data, leading to the need for more patient-focused studies.

Healthcare services have traditionally been considered individually customised craftsmanship services (Bohmer, 2005; McLaughlin and Kaluzny, 2000), and they have been evolving towards mass production and mass customisation (McLaughlin and

Kaluzny, 2000). Many healthcare services are moving from individually customised services towards standardised services. However, this process was not evident in all of the eligible studies; most focused on the customisation dimension of mass customisation. One reason why most of the eligible studies focus on the customisation dimension of health service delivery may be related to how healthcare has advanced over the recent decades. Traditionally, the medical needs of patients have been the main drivers of healthcare and care development.

The three outcome dimensions used in this study may also differ regarding their prioritisation; the fulfilment of different patient needs (i.e. the customisation dimension) may be viewed as the most valuable and basic outcome of medicine, and the other outcomes may not be considered as important. This could imply that the general focus of these studies is on the evolution of mass-produced services into more customised services. It is, however, important to recognise that most of the eligible studies identified in this systematic review focus on elderly or home care and thus the generalizability of the results to other healthcare areas may be limited. Nonetheless, as there is a clear gap in empirical studies underlining the effects and outcomes of mass customisation and modularisation, it is quite challenging to understand the economic impact of these operating models.

The economic impact and patient experience dimensions should not be underestimated; patient satisfaction and patients' perception of quality have become important aspects related to the quality of care (Sofaer and Firminger, 2005). Similarly, the need to monitor the cost of care delivery and improve population health has been identified (Berwick et al., 2008). Means to increase patient satisfaction should be considered, because a high level of

patient satisfaction is known to relate to higher adherence rates (Golin et al., 1996), which may, consequently, reflect population health. The rather small number of studies including direct patient interviews or questionnaires may similarly indicate that patient experience is not considered important in the fulfilment of medical needs. However, the small amount of direct information available on patient satisfaction may also point to the limited amount of research on mass customisation in healthcare. Nonetheless, patient experience is often influenced by environmental and provider characteristics in addition to patient characteristics. Patients tend to link the quality of care with patient-centredness (Sofaer and Firminger, 2005) and the quality of patient-professional interaction. Although this is only one perspective related to the quality of care, it underlines the need to study the effects of mass customisation on patient satisfaction and patients' perception of services.

Current literature offers little empirical evidence of success in the implementation of mass customisation in healthcare services. This scoping review demonstrates that mass customisation and modularisation may be applicable in healthcare. However, as current literature does not focus on empirical evidence of success nor on the enablers of mass customisation and modularisation, there is a need for more comprehensive empirical studies of these operating models. Only after this, it is possible to analyse the potential benefits and the success of these managerial models. Moreover, there is a need for quantitative and mixed methods studies to increase the generalizability of findings related to the applicability and outcomes of mass customisation and modularisation in different healthcare fields and systems. Future studies are needed to understand limitations and challenges related to the mass customisation of healthcare services.

5. Practice Implications

This scoping review demonstrates that mass customisation and modularity may be means to increase patient satisfaction and fulfilment of patient needs while simultaneously managing costs. However, this review indicates that mass customisation and modularisation studies on healthcare delivery are scarce, and that most studies focus on the customisation dimension of mass customisation rather than patient experience or costs. Most studies focus on elderly or home care and use the descriptive case-study method. Thus, rigorous empirical quantitative and mixed methods research is needed to gain more knowledge about the applicability of mass customisation and modularisation in different healthcare areas and the outcomes of these operating models.

6. Conflict of interest

The Authors declare that there is no conflict of interest.

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8. Tables and Figures

Table 1: Screening protocol and study selection process

Screening protocol questions	Yes= continue to next step	No= exclude
<p>A. General questions</p> <p>a. Does the study concern health service delivery and not only medical (clinical) decision making? AND</p> <p>b. Does it concern process improvement or theoretical analysis of how mass customisation or modularisation can be used in healthcare?</p>		
<p>B. General questions regarding language and publication</p> <p>a. Is the study written in English?</p> <p>b. Is the study published in a peer-reviewed journal (conference papers excluded)?</p> <p>c. If the study is open access, does the journal have a documented peer review process?</p>		

Table 2: Basic information of the studies included in the qualitative analysis ordered by publication year, organisation category included (please see section 3.1)

Authors and publication year	Title	Journal	Research design	Data	Setting	Key findings	Search	Organisation category
de Blok C. et al. (2014)	Interfaces in service modularity: A typology developed in modular healthcare provision	Journal of Operations Management	Case study (multiple)	38 semi-structured interviews (personnel); observation; document analysis	Elderly care (residential or home care)	The identification and description of interfaces in service modularity: the interfaces were divided into two categories by aim—variety and coherence.	Scopus	Modularisation
Minvielle E. et al. (2014)	Managing customisation in healthcare: A framework derived from the services sector literature	Health Policy	Conceptual	Literature	Health services	A framework to enable implementation of care process customisation, including six factors: patient categorization, IT, development of service skills, improving patient self-management, patients' experiences and economic impact	Scopus	Mass customisation
Soffers R. et al. (2014)	Modular health services: A single case study approach to the applicability of modularity to residential mental healthcare	BMC Health Services Research	Case study (single)	7 semi-structured interviews (personnel); observation; document analysis	Health services (mental)	The potential of modularisation of case organisation, with further steps proposed to enhance modularity	Scopus	Modularisation

Kertesz S.G. et al. (2013)	Comparing homeless persons' care experiences in tailored versus nontailored primary care programs	American Journal of Public Health	Survey	Semi-structured interviews (36 homeless patients, 22 experts); face-to-face survey for homeless patients (n=601)	Health services (primary)	Tailored services associated with a better service experience	Scopus	Mass customisation
Doner Lotenberg L. et al. (2013)	Lessons learned from a survey of the diagnosis and treatment journeys of postmenopausal women with hypertension	Journal of Clinical Hypertension	Case study (single)	6 in-depth phone interviews; 300 online surveys (patients)	Health services	Mapping of the diagnosis and treatment journeys of postmenopausal hypertension patients and development of a vignette of a prototypical postmenopausal woman with hypertension	Scopus	Segmentation
Chaudhuri A., Lillrank P. (2013)	Mass personalization in healthcare: insights and future research directions	Journal of Advances in Management Research	Conceptual and case study	Literature; interviews; observation	Health services	Identification of issues related to mass personalization of healthcare through a case in the Indian healthcare industry	Other	Mass customisation
de Blok C. et al. (2013)	The human dimension of modular care provision: Opportunities for personalization and customisation	International Journal of Production Economics	Case study (multiple)	38 semi-structured interviews (personnel); documents; observation	Elderly care (residential or home care)	Further customised modularised services in elderly care that may be provided by personalization through adaptation of supply to demand	Author snowballing	Mass customisation and modularisation
Benning T.M. et al. (2012)	Combining individual-level discrete choice experiment estimates and costs to inform healthcare management	Value in Health	Case study (single)	Literature; policy initiatives; expert opinions; 2 surveys for patients (n=331)	Health services (specialised)	A fully customised (chosen from current service pallet) follow-up as an accountable option, superior to the other options with regard to both cost of service and utility	Scopus	Mass customisation

	decisions about customised care: The case of follow-up strategies after breast cancer treatment					to the patient. The emphasis of cost and effectiveness should be taken into account in organisations as there is no explicit single best follow-up program.		
Vahatalo, M. (2012)	Modularity in health and social services: a systematic review	International Journal of Public and Private Healthcare Management and Economics	Systematic review	Literature	Social and health services	The need for joint delivery and coordination was recognised. However, organisational interfaces are not described and modular partnerships are not formed.	Reference Snowballing	Modularisation
Machado Guimarães C.M., Crespo de Carvalho J.C. (2012)	Outsourcing in healthcare through process modularisation- A lean perspective	International Journal of Engineering Business Management	Case study (single)	7 semi-structured interviews (personnel and consultant); documents, observation	Elderly care	Division of the service value chain into modules through a process approach by using Lean: this enables the standardization of outputs and activities and identifies options for outsourcing.	Scopus	Mass customisation
de Blok C. et al. (2010a)	Improving long-term care provision: Towards demand-based care by means of modularity	BMC health services research	Case study (multiple)	38 semi-structured interviews (personnel); documents; observation	Elderly care (residential or home care)	Case organisations use modularity, which enables the variation of choices given to clients and enables care and service package customisation and client involvement management.	Author snowballing	Modularisation
de Blok C. et al. (2010b)	Modular care and service packages for independently living elderly	International Journal of Operations and	Case study (multiple)	38 semi-structured interviews (personnel); documents; observation	Elderly care (residential or home care)	Early client involvement leads to lower customisation through combinations of standard components. Late client	Scopus	Mass customisation and modularisation

		Production Management				involvement leads to a higher degree of customisation as it enables the adaptation of components.		
Meyer M.H. et al. (2007)	Applying platform design to improve the integration of patient services across the continuum of care	Managing Service Quality	Case study (single)	Study group discussions; 15 Interviews of management; discussions; documents	Health services	To improve medical quality, patient satisfaction and operational costs in the organisation, a case management approach with a modular platform design was recommended.	Scopus	Mass customisation
Van Campen, C., Woittiez, I.B. (2003)	Client demands and the allocation of home care in the Netherlands. A multinomial logit model of client, care needs and referrals	Health Policy	Case study (single)	Sample (n=7732) from intake registration system (GINO) of home care applicants	Home care	Establishment of a model to estimate how care needs and demographic characteristics influence the choice of home care packages.	Reference Snowballing	Mass customisation
Thompson M., Nussbaum R. (2000)	An HMO survey on mass customisation of healthcare delivery for women	Women's Health Issues	Survey	Telephone survey (n=1000), focus group interviews (n=10), semi-structured individual interviews (n=75)	Health services	Differences in preference for gender and schedule hours between subgroups of women: statistically relevant differences were found between women over and under 55 years with regard to scheduled hours and preference for the physician's gender.	Scopus	Mass customisation
McLaughlin C.P., Kaluzny A.D. (2000)	Building client centered systems of care: Choosing a process direction for the next century	Healthcare Management Review	Conceptual	Literature	Health services	Analysis and description of the directions of future healthcare management and the role of different operational management perspectives	Scopus	Mass customisation

Fairchild D.G. et al. (1998)	A prediction rule for the use of postdischarge medical services	Journal of General Internal Medicine	Epidemiological (cohort Study)	Patient questionnaires (n=714); patient data from hospital database; telephone interviews (n=476)	Health services (specialised)	Development of a prediction rule for post-discharge medical service use, and segmentation of patients into three groups: low-risk, intermediate risk and high risk.	Scopus	Segmentation
Hogg W.E. et al. (1998)	Randomized controlled study of customised preventive medicine reminder letters in a community practice	Canadian Family Physician	Epidemiological (case control)	Three groups of patients (n=1971)	Health services (primary)	Writing of a customised letter to encourage patients to seek appropriate preventive services and increase compliance with preventive procedures	Scopus	Mass customisation

Table 3: Terms used in the studies related to segmentation, modularity, customisation and mass customisation

Segmentation	Modularity	Customisation	Mass customisation
Population (Kertesz et al., 2013)	Programme (as in care package) (Benning et al., 2012)	Tailored (Kertesz et al., 2013)	Mass personalisation (Chaudhuri and Lillrank, 2013)
Subgroup (Doner Lotenberg et al., 2013; Thompson and Nussbaum, 2000)	Package prototype (de Blok et al., 2013)	Menu of choice (de Blok et al., 2010a)	
Categorisation or category (Fairchild et al., 1998; Meyer et al., 2007)	Standardised components (de Blok et al., 2013)	Package specification (de Blok et al., 2010a)	
Group or grouping (Doner Lotenberg et al., 2013; Fairchild et al., 1998; Van Campen and Woittiez, 2003)	Construction of care packages (Van Campen and Woittiez, 2003)	Case management in service architecture (Meyer et al., 2007)	
Classification (Van Campen and Woittiez, 2003)		Referral to care package (Van Campen and Woittiez, 2003)	
Separating patients (Vähätalo, 2012)		Personalisation (Minvielle et al., 2014)	

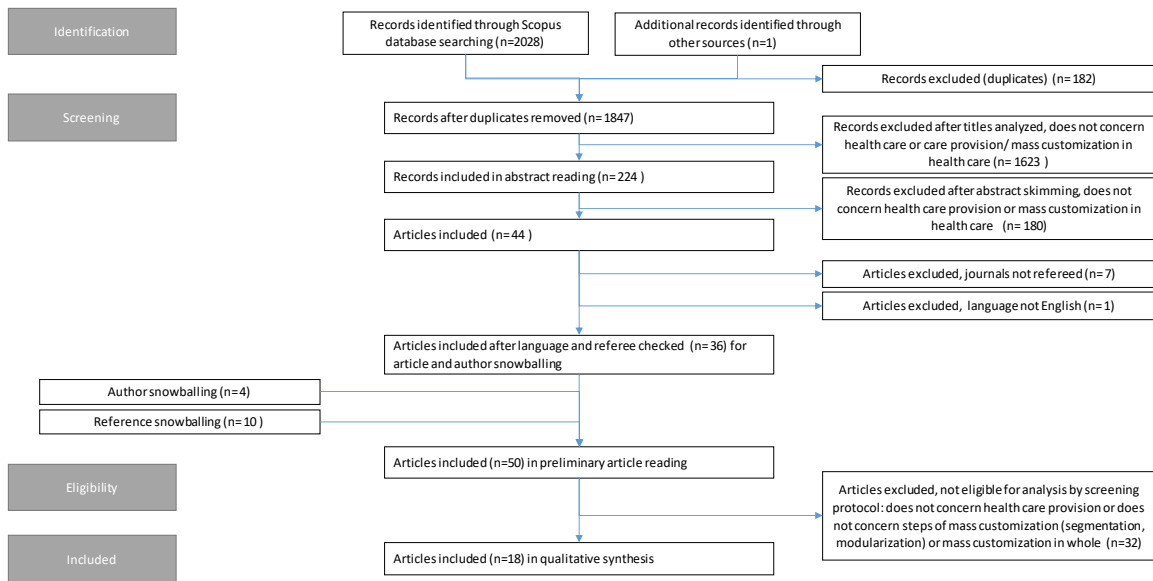


Figure 1: Study selection process

Additional File 1: Search Strategy

Search	Search Terms, source: SCOPUS	Results of search, duplicates of search removed	Date of search
1	((("mass customization" OR "mass customisation" OR "mass-customization" OR "mass-customisation" OR "mass personalization" OR "mass personalisation" OR "mass-personalization" OR "mass-personalisation") AND (health OR "health-care" OR "healthcare" OR healthcare OR care))	45	14.10.2014
2	((("mass customization " OR "mass customisation" OR "mass-customization" OR "mass-customisation" OR "mass personalization" OR "mass personalisation" OR "mass-personalization" OR "mass-personalisation") AND ("health sector" OR "health-care sector" OR "healthcare sector" OR "healthcare sector"))	2	14.10.2014

3	((("mass customization " OR "mass customisation" OR "mass-customization" OR "mass-customisation" OR "mass personalization" OR "mass personalisation" OR "mass-personalization" OR "mass-personalisation") AND ("health service" OR "health-care service" OR "healthcare service" OR "healthcare service")))	7	14.10.2014
4	((("mass customization " OR "mass customisation" OR "mass-customization" OR "mass-customisation" OR "mass personalization" OR "mass personalisation" OR "mass-personalization" OR "mass-personalisation") AND ("health process" OR "medical process" OR "patient process")))	-	29.9.2014
5	((("mass customization " OR "mass customisation" OR "mass-customization" OR "mass-customisation" OR "mass personalization" OR "mass personalisation" OR "mass-personalization" OR "mass-personalisation") AND ("health-care management" OR "healthcare management" OR "healthcare management")))	3	14.10.2014
6	((("mass customization " OR "mass customisation" OR "mass-customization" OR "mass-customisation" OR "mass personalization" OR "mass personalisation") AND "patient centered care"))	3	14.10.2014
7	((("service personification" OR "service design") AND ("patient centered care" OR "patient-centered care" OR "medical process" OR "health process" OR "patient process")))	17	14.10.2014
8	((("service personification" OR "service design") AND (health OR "health-care" OR "healthcare" OR healthcare))	997	14.10.2014
9	((("service personification" OR "service design") AND ("healthcare services" OR "healthcare services" OR "health-care services")))	112	14.10.2014
10	("modular services" AND ("healthcare" OR healthcare OR "health-care" OR care OR "patient centered care"))	10	14.10.2014
11	("service modularization" AND ("healthcare" OR healthcare OR "health-care" OR care OR "patient centered care"))	-	29.9.2014
12	("service modularity" AND ("healthcare" OR "healthcare" OR "health-care" OR care OR "patient centered care"))	4	14.10.2014
13	("total quality management" AND ("healthcare services" OR "health service" OR "health-care service" OR "healthcare service") AND ("mass customization " OR "mass customisation" OR "mass-customization" OR "mass-customisation"))	2	14.10.2014
14	("customer focus" AND ("healthcare services" OR "health service" OR "health-care service" OR "healthcare service"))	25	14.10.2014
15	("service operations" AND ("mass customization " OR "mass customisation" OR "mass-customization" OR "mass-customisation" OR "mass personalization" OR "mass personalisation" OR "mass-personalization" OR "mass-personalisation") AND (health OR "health-care" OR "healthcare" OR "healthcare" OR care))	-	29.9.2014
16	("personalized medicine" AND ("health-care management" OR "healthcare management" OR "healthcare management") AND (process OR "health service" OR "service design"))	18	14.10.2014
17	((("agile-production" OR "agile production") AND (health OR "health-care" OR "healthcare" OR healthcare OR care))	2	28.10.2014
18	((("mass customization" OR "mass customisation" OR "mass-customization" OR "mass-customisation" OR "mass personalization"	1	28.10.2014

	OR "mass personalisation" OR "mass-personalization" OR "mass-personalisation") AND ("care pathway" OR "care journey"))		
19	((("mass customization" OR "mass customisation" OR "mass-customization" OR "mass-customisation" OR "mass personalization" OR "mass personalisation" OR "mass-personalization" OR "mass-personalisation") AND ("care pathway" OR "care journey"))	-	28.10.2014
20	("service modularization" AND ("healthcare integration" OR healthcare integration" OR " patient-centric" OR "patient centric" OR "patient-level integration"))	-	28.10.2014
21	("healthcare integration" OR healthcare integration" OR " patient-centric" OR "patient centric" OR "patient-level integration"))	754	28.10.2014