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(Full Paper)

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ABSTRACT

Community pharmacies deliver accessible and personalized health care to populations worldwide. Provision of medicine therapy is central to this business but the continuous interactions with clients in their homes is problematic. This paper models an ecosystem of wellness for community pharmacies and presents five generations of smart pharmaceutical care systems (SPCS) for home interventions. Our project follows the design science research paradigm and is supported in a literature review of 31 recent information systems papers. Two key challenges of Health 5.0 are addressed: digital medication management and sustainable medicine use. SPCS reveal potential to change the business model of community pharmacies. However, spanning the pharmacy boundaries with digital technologies requires (1) socio-technical strategies to differentiate their offer, (2) technologies tailored to the needs of each client, (3) collective intelligence production in medicine supply chains, and (4) humanized telecare.

Keywords: Smart Pharmaceutical Care, Community Pharmacy, Smart PillBox, Medicine Management, SPCS.

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INTRODUCTION

Community (or retail) pharmacies are at the forefront of health care assistance to local population, thereby particularly relevant to address the proximity needs of an ageing society. The foundational mission of medicine provision is now integrated in a diversified product portfolio that includes medical devices and advice in nutrition, or fitness. Online interaction and smart products pave the way for pharmacist-driven smart health care, "*to engage patients more proactively with their prescribed therapy using mobile communication and devices*" (Gatwood, Hohmeier, & Brooks, 2019).

The "5.0" movement of human-centered development in industry (Bednar & Welch, 2020) is also transforming the vast health care sector. For example, exploiting the internet of things, cloud, mobile, autonomous robots, and artificial intelligence (AI) for personalized treatment (Javaid & Haleem, 2019). Technology serving human purposes and sustainable goals will be a priority for sociotechnical transformation (Bednar & Welch, 2020) and "Health 5.0" promises major advances in health data connectivity, machine and artificial intelligence integration, and ecosystems of wellness (QUT, 2018). However, community pharmacies are still in the early stages of digital transformation (Gatwood et al., 2019) and many customers are struggling to manage their medication. The work of Beuscart et al. (2019) supports the urgent need to extend pharmacy intervention to the home, particularly for some segments of the population facing "*medication storage problems (21.7%), expired medications (40.7%), potentially inappropriate medications (15.0%), several different generic versions of the same drug (19.9%), and redundant medications (20.4%)*" (Beuscart et al., 2019).

Physical devices such as electronic pillboxes appeared a few decades ago (e.g., Hayes et al. (2006)) and can be used to implement telecare (Karlsen, Haraldstad, Moe, & Thygesen, 2019). However, the vision embodying human-centered digitalization of pharmacies has many unanswered questions. For example, programmable smart pillboxes can send reminders and organize medication, but its capacity to be personalized to the needs of each patient is limited and its effectiveness vary (e.g., depending on the diseases, patient characteristics, type of medication). We highlight three related research opportunities revealed by Singh and Varshney (2020): *new theoretical models for IT-based reminders, integration of new emerging technologies (e.g., AI), and the potential of combining reminders with other solutions*.

How community pharmacies can go "*beyond the reminder*" (Gatwood et al., 2019) with physical-digital solutions to provide pharmaceutical care at home is the main challenge that we address in this paper. Two research questions are formulated: *RQ1: How recent Information Systems (IS) literature addresses the topic of smart pharmaceutical care?* and *RQ2: What types of IT-based medication management can project the community pharmacy intervention into home health care?* These questions inquire the knowledge base to understand "*what is available*" (Thuan, Drechsler, & Antunes, 2019) and the "*way of framing*" the inner world (internal structure) and the outer world (requirements and properties) of artefacts (Simon, 1996; Thuan et al., 2019) for the selected research context.

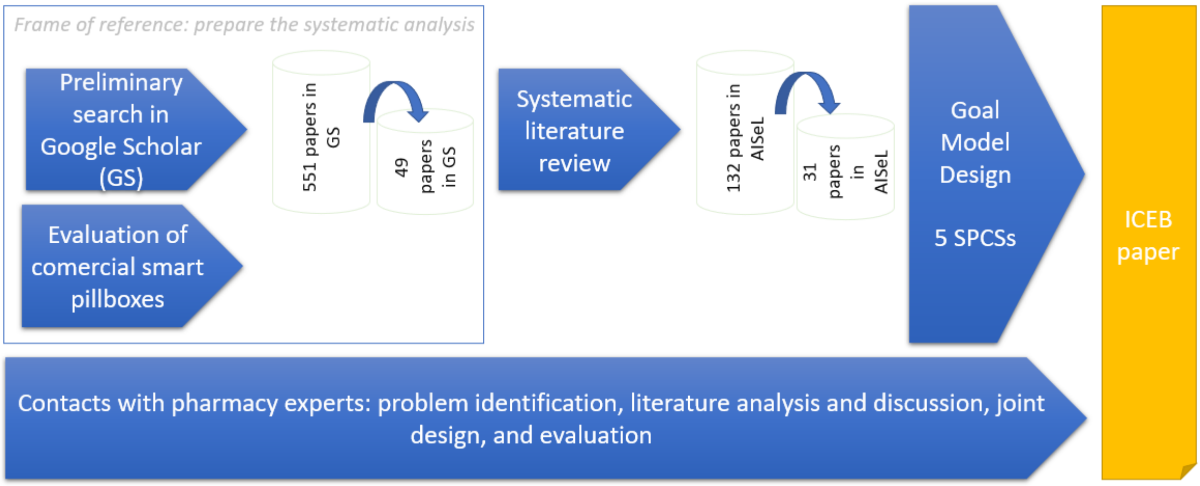
The rest of this paper is organized as follows. The next section explains our design science research (DSR). Afterwards, the results of a systematic literature review of 31 information systems publications are detailed. Subsequently, five types of smart pharmaceutical care systems (SPCS) are modelled. The discussion follows, stating the limitations and future research opportunities. The paper closes with the main conclusions.

RESEARCH APPROACH

Our joint-research project with a community pharmacy follows design science research to produce a new model (Hevner, March, Park, & Ram, 2004). The pharmacy shareholders have recently invested in a private clinic and aim to create an ecosystem of wellness, projecting their sphere of influence into home health care.

Design science is a research approach that evolves in steps of *(1) problem formulation and motivation, (2) define objectives of the solution, (3) design and development, (4) demonstration, (5) evaluation, and (6) communication* (Peffers, Tuunanen, Rothenberger, & Chatterjee, 2007). Our research entry point (Peffers et al., 2007) is the initial step of problem formulation and motivation, considering the novelty of the topic for community pharmacies and the lack of SPCS instantiations for home intervention in this context. Digital technologies give form to the pharmacy owners' ambitions, and they have heard about recent advances in smart pillboxes and medication reminders (Singh & Varshney, 2020; Solís, Cedillo, Parra, Guevara, & Ortiz, 2017). The pharmacists were interested in smart and connected devices (Porter & Heppelmann, 2015) able to (1) strengthen their bonds with the end users, (2) increase medication adherence, (3) support inventory planning, and (4) positively impact their customers' quality of life. According to the pharmacy owners, the replacement of traditional pillboxes (plastic recipients used for organizing medicines) by high-tech solutions with prices that can reach hundreds of dollars is unaffordable to many customers. Moreover, an app would be appealing, but still insufficient to enforce medicine safety (e.g., locks) and there are barriers to mHealth in many segments of the elderly population.

RQ1 aims to clarify the actors, goals, and tasks of smart pharmaceutical care. The most disruptive opportunities with Health 4.0 and Health 5.0 are still nascent and sociotechnical. Therefore, our search strategy pointed to recent literature in the field of information systems, not restricting journals or conferences. The research process is explained in Figure 1.



Source: This study.

Figure 1: DSR Research Process.

The first phase aimed to create a frame of reference. Google Scholar was selected due to its broad coverage. The keywords used were: *("smart pillbox" OR "smart pill box" OR "pill dispenser" OR "medicine dispenser") AND "information system"* returning 153 results; *"reminders" AND "adherence" AND ("pill box" OR "pillbox") AND "information systems"*, with 151 hits since 2015; *"smart pillbox" OR "smart pill dispenser" OR "automatic pill dispenser" + sensor* with 55 results in the past two years. We also included general terms such as *"smart pillbox"*, checking the highest cited papers (>9 with 224 results). A total of 49 papers were evaluated by the team at this phase to identify relevant keywords, trends, and technologies available. Additionally, commercial solutions were checked by the research team to understand key features (e.g., alarms, mobile interfaces, medicine traceability). For example, Pria™ by Black & Decker, Philips Lifeline, Hero, or RxPense®. There are also solutions for reminders and organizers (e.g., MedQ) that can also include locks (e.g., Med-E-Lert™).

Subsequently, we conducted a systematic literature review (Webster & Watson, 2002) in AIS Electronic Library (AISeL), using the keywords (tuned in the previous round): *pillbox OR "medication adherence" OR "medicine adherence" OR "pill dispenser" OR "pill box" OR "medicine dispenser" OR "medication dispenser" OR "drug dispenser" OR "medicine reminder" OR "pill reminder" OR "medication reminder"* (132 results since 2015). AISeL was selected because it is one of the most important databases for the IS community, including top conferences and journals. Moreover, it facilitates full access to the sources. Finally, we also screened titles of papers published before 2015 to ensure that no critical topic was missing. Since our purpose was to identify the most recent contributions to the topic, we restrict the selection to papers (in conferences or journals) published in the past two years (2019 and 2020), and journal articles published since 2015. Other exclusion criteria were papers restricted to the more technical details (e.g., specific portals), short papers, related work conducted by the same authors, or addressing different outcomes (e.g., research methods).

A total of 31 papers were selected for inclusion in the concept-centric review presented herein. After describing the problem and the input knowledge, we continue our DSR process (vom Brocke & Maedche, 2019) with the construction of SPCS models. Five types of *IT-based medication management* (used interchangeably with SPCS) for the unique context of community pharmacies are identified and modelled with i* (i-star) language (Yu, 1997). The i* language can be used for strategic reasoning but also to understand the needs of different actors, "*shifting focus from value exchange and creation to stakeholder goals, motivations, and intentions*" (Samavi, Yu, & Topaloglou, 2009). The i* language was considered accessible by our case pharmacy company to identify SPCS requirements.

SMART PHARMACEUTICAL CARE: INSIGHTS FROM THE IS FIELD

Models connecting people, data, and technology can assist decision making but it is essential to understand how "*can these models be developed to incorporate the needs of the patient, what works and what does not work for the patient, and how can the provider intervene effectively at a particular point in time given the history of care*" (Bardhan, Chen, & Karahanna, 2020). Pill dispenser technology is included in the extensive list of Mhealth tools connected to smartphones and sensors (Gerhardt, Breitschwerdt, & Thomas, 2018). Yet, it is necessary "*more research that focus on wearables and sensors, such as those in smart homes*" (Imre & Wass, 2019). The following subsections detail (overlapping) concepts of design, use, value, and market of "smarter" pharmaceutical care.

System Design

Multiple stakeholders must collaborate "*in ensuring that the e-health system fits the learning needs of the individual and satisfies the ethical standard of due care*", but also in effective communication during self-care management, learning (Chiasson, Kelley, & Downey, 2015), and experience (Yang, Guo, Peng, Lai, & Luo, 2020). The work of Gao et al. (2019) presents questions that must be addressed by systems designers, for example, the roles of each entity, (multidimensional) integration, process adaptability, or usability. However, studies covering community pharmacies and IT-based collaboration are clearly insufficient.

Health 4.0 includes a plethora of technologies that can be integrated. Health 5.0 (QUT, 2018) turns the spotlight to human-machine relations and sustainability. For example, wearables can produce information valuable to the user (Behne et al., 2020). Yet, there are challenges in complex innovation processes involving multiple stakeholders, as revealed by a longitudinal study of medical dispensing robots (Aaen, 2019). The case includes nine municipalities and four companies, highlighting both technical (e.g., some errors can compromise the user's confidence in the system) and social issues (e.g., mobilizing testers).

Other authors adopt a holistic stance in digital health design. The architecture for smart systems proposed by Strobel and Perl (2020), offers a starting point to the development of solutions in this field. A conceptual model for a data-driven solution in health care was tested by Burkhardt and Burkhardt (2020) using a scenario "*that integrates different data supporting the patient in his home environment. For example, it monitors the medication box, orders medicine, reports drug misuse, books doctor appointments or reports the health status*" (Burkhardt & Burkhardt, 2020). This home assistant scenario was envisioned by a health expert and medication availability, adherence, and monitoring are top priorities.

System Use

The work of Azad and King in hospital settings (e.g., Azad and King 2008) is frequently cited in workarounds research. Beerepoot et al. (2020) uncovered which workarounds are more likely to be accepted or rejected. Although their work does not address community pharmacies, it is probable that workarounds involving patients (e.g., pillbox user) or expert knowledge in complex decisions are more likely to be unacceptable, while some workarounds involving collaboration may be acceptable. The phenomena should be closely monitored, particularly in the cases of medication recording (Beerepoot, 2019).

Incentives to promote adherence to devices and digital platforms are essential. For example, using persuasive trigger messages (Sittig, Franklin, & Sittig, 2020). Moreover, physical materialities can be used to increase information reliability and it is possible to design reminders with different type of messages to reinforce patient adherence (X. Liu & Varshney, 2019).

Gamification can be explored to improve medication adherence (Schmidt-Kraepelin, Warsinsky, Thiebes, & Sunyaev, 2020). Other examples include personalization and fair information practices – originally proposed for personal health records (Gabel, Münster, Nüesch, & Gabel, 2019), that could be extended to nursing home scenarios. A recent study about the acceptance of health chatbots was conducted by Mesbah and Pumplun (2020), extending UTAUT2 with factors such as resistance to change, need for emotional support, technology anxiety, and privacy. The important role of users emotions is also confirmed by Savoli, Barki, and Pare (2020). These contributions can be adopted in pharmacy contexts where quality of life is a priority.

System Value

Karlsen et al. (2019) present an inspiring study about telecare affordances in home care services, ranging from simple personal alarms or reminders to more advanced medicine dispenser robots and external devices (e.g., cameras or door sensors). These authors conclude that "*the actualization process was strongly influenced by contextual factors, where anchoring and* *cooperation, competence and knowledge, and routines and follow-up were considered the most prominent factors*" (Karlsen et al., 2019).

Reminders and motivational functions are two proven effective strategies to improve elderly health (N. Liu, Yin, Wongmaneeroj, & Teo, 2020), preventing health problems, and reducing affluence to health care structures. Prevention is key, for example, in asthma treatments (Son, Flatley Brennan, & Zhou, 2020). Another example presented by Varshney and Singh (2020) shows the adoption of IT (mobile apps, devices, and sensors) for the prevention of opioid-based disorders.

Dobson et al. (2019) identified savings close to 50% if the hospital adopts enhanced inventory management practices, when comparing to the usual approach to automated dispensing systems. For home contexts, there are opportunities for ambient assisted living "*that not only includes the latest base technological innovations but also responds to recognized user needs in a way that is easy to understand and based on a series of interconnected device-generated data*" (Bozan & Berger, 2019). However, there is still a lack of medicine-centered studies integrating physical and digital materialities.

Information Value

Valuable data can be generated in electronic health processes, perhaps more visible in processes linking the pharmacy and the hospital (Xie, Palvia, & Vance, 2020), but pharmacies are also deeply intertwined with the industry, experts and carers (e.g., nursing homes).

Smart pharmaceutical care systems maximize its value when the information is bidirectional. On the one hand, smart devices can provide information to support the users (Bozan & Berger, 2019). On the other hand, information collected by the devices (or manually inputs in the case of apps) are important for health care supply chains. For example, to evaluate the service provided by nursing homes (e.g., efficiency, errors), the effect of medication, and anticipate medicine orders.

Pillbox information can reduce medication errors (Johnsen, Fruhling, & Fossum, 2016). Existing systems aiming to reduce inappropriate prescribing in polypharmacy contexts are advancing fast. However, collective intelligence (Marsh, Carroll, & Foggie, 2011) that is increasingly produced by humans and machines is not yet being employed in existing robot-dispensing systems, limiting the full potential for decision-support and sustainable use of medication in ecosystems of wellness.

Market Innovation

The combination of new electronic medicine dispensing and business model innovations is possible, but may fail if they are based in short term vision (Heikkilä, Bowman, & Heimo, 2019). Moreover, innovation in ecosystems of wellness is complex. A recent case study presented by Wainwright et al. (2020) describes telehealth care services adoption (including multiple electronic devices and medication dispensers). They conclude that additional work is necessary to fully understand the ecosystem involved (Wainwright et al., 2020). Public-private collaborations can create a broader digital infrastructure (Kempton & Brænden, 2020). However, when the process is initiated by a (small or medium) private community pharmacy, the support of public co-funded projects to explore value in technology and data seems to be appropriate.

There are five main assumptions that IS researchers must be aware when creating new systems that "*adapt to situations, perceive their environments, and interact with humans and other technologies*" (Schuetz & Venkatesh, 2020): "*(1) the direction of the user- artifact relationship, (2) the artifact's awareness of its environment, (3) functional transparency, (4) reliability, and (5) the user's awareness of artifact use*". These authors present the example of reminders that benefit from adaptivity in different contexts, making them more effective in the future. However, a single smart device does not seem sufficient to ensure personalized pharmaceutical care in all contexts and address the goals of different stakeholders in ecosystems of wellness. Therefore, the next section distinguishes and models five smart pharmaceutical care systems, with different levels of connectivity.

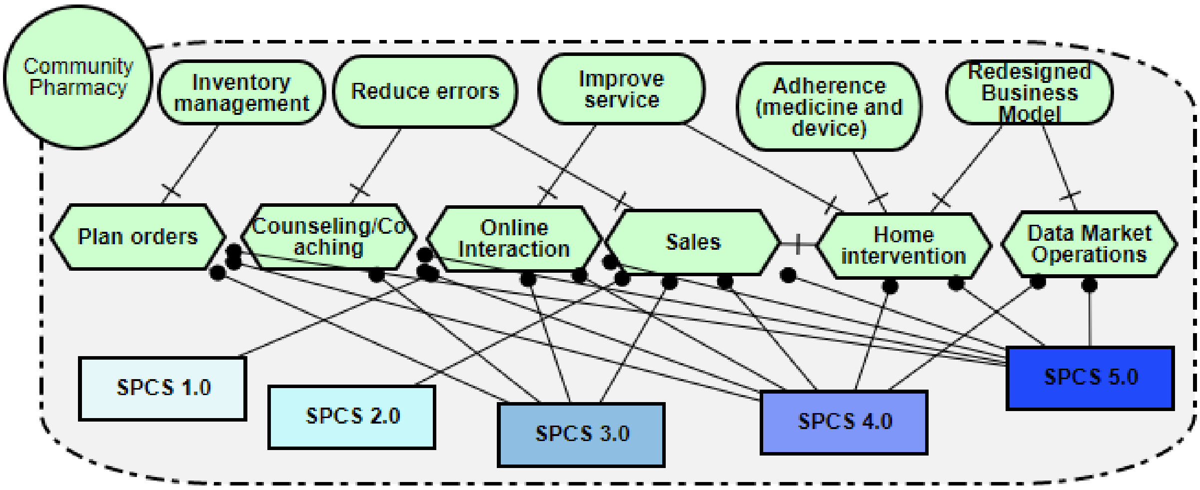
MODELLING ECOSYSTEMS OF WELLNESS FOR COMMUNITY PHARMACIES

This section presents the models created by researchers and practitioners to project the case pharmacy into home health care.

The models are built with i* (Yu, 1997), originally proposed for requirements engineering. The key elements are (Yu, 1997): the actors (◌), the goals (⬭), the soft goals (☁) - differ from the former due to the lack of a precise classification, the tasks of that actor (⬡), and the resources needed (SPCS versions). For the sake of simplicity, only the most relevant elements are shown, the soft goals are restricted to the society actor, and dependencies between actors are omitted.

Five SPCSs are modelled according to the literature findings described in the previous section and the strategy of the selected community pharmacy. The simplest SPCS is 100% digital: static web sites and/or SMS reminders (SPCS 1.0). It is also possible to find cases of pure physical devices (SPCS 2.0, no connectivity) for organizing the pills, providing alarms, or locks to increase safety. SPCS 3.0 are 100% digital systems with bidirectional interaction, for example, apps for monitoring medication adherence that are popular in the literature. SPCS 4.0 incorporates Industry 4.0 technologies and offers a combination of physical (smart pillboxes, smart watch) and digital (apps) layers. Finally, SPCS 5.0 envisions the next generation of human-centered solutions with smart home devices (e.g., smart cabinets), and digital capabilities to support societal goals (beyond interaction between patients and carers that is the usual scenario in SPCS 4.0).

The main actors identified in the smart pharmaceutical care systems are the community pharmacy (case company), the patient and the carers (e.g., nursing home context), the society, and the clinic (actor external to the pharmaceutical administration process but included in the desired ecosystem). Figures 2-4 describe the goals, soft goals (selected to represent societal needs), the tasks performed in home care scenarios, and the support that each type of SPCS − ranging from the simpler digital SPCS 1.0 with reminders to the more advanced and integrated devices in SPCS 5.0.



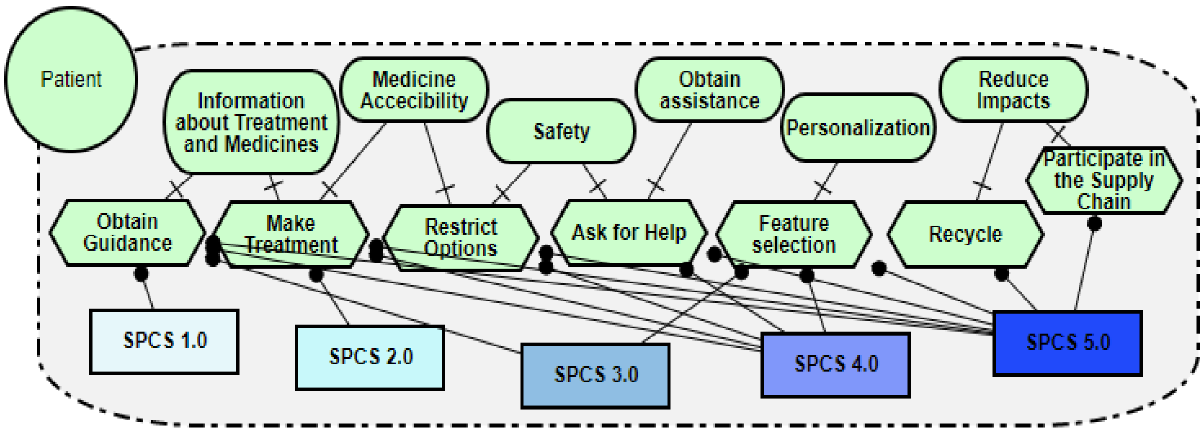
Source: This study.

Figure 2: Goal Model for SPCS Design: The Community Pharmacy.

The literature review indicates that important savings are possible with proper inventory management (Dobson et al., 2019) and that automatic pill dispensers can reduce errors (Johnsen et al., 2016). However, these goals are difficult to achieve with reminders (e.g., via SMS) or traditional pill boxes. The business value of SPCS 1.0 and 2.0 (resources on the bottom-left of Figure 2) is more visible in the case of direct sale: (1) reminders to assist their customers after purchasing medicines and (2) the incorporation of (physical) medicine dispensing devices increasing their product portfolio.

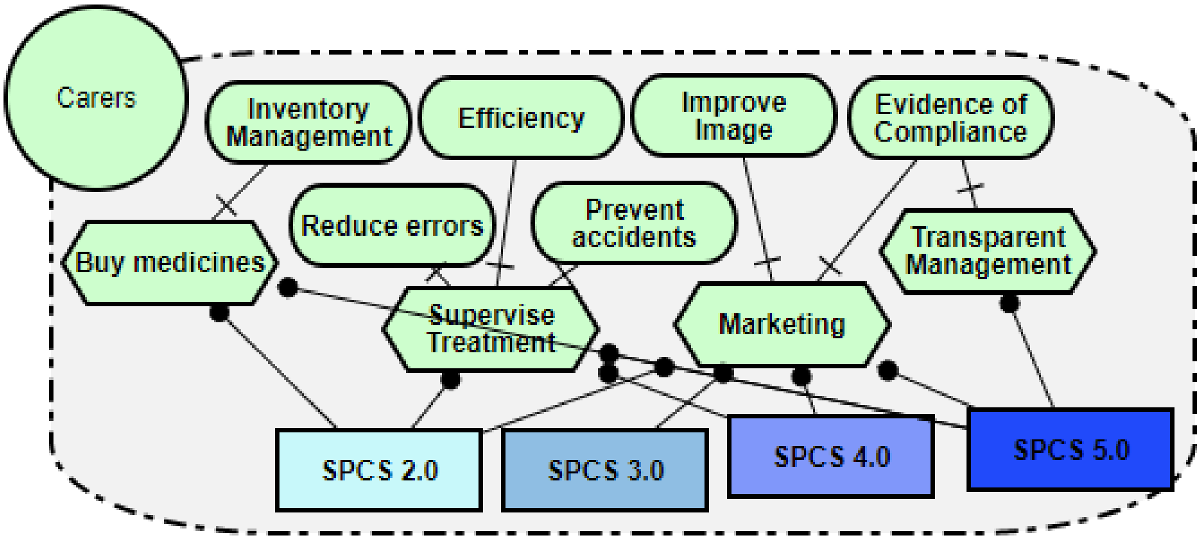
SPCS 3.0 (apps) adds more value to the internal processes of the community pharmacy (e.g., plan orders - the user can insert their needs via app) because bidirectional communication becomes possible. Some pharmacies are already exploring this type of SPCS (Davies, Collings, Fletcher, & Mujtaba, 2014), but only with the fourth and fifth generations the pharmacy can aspire to transform their business model with telecare. In fact, the lack of a physical layer in SPCS 3.0 also limits its potential to improve medication adherence, real-time monitoring of the medicine dispenser, and collecting data from nursing homes. The shift to "5.0" needs connectivity between the medicine dispensing device and other objects of the patient's environment.

According to one of the community pharmacy owners, existing medicine dispensing systems are not able to store large quantities of different medications, some of them occasionally used. Smart cabinets connected to the dispensing system can extend the value of the solution with inventory management (1) in the individual dispensing system and (2) in the patient environment. Moreover, SPC 5.0 could improve planning deliveries to nursing homes and monitoring if stock variations are explained by the individual dispensing devices (nursing homes need smart medicine dispensers for multiple patients), producing more data to prevent errors, improve service, and project redesigned home care services by community pharmacies. Figure 3 presents the patient (3-a) and carers (3-b) model (both models can be integrated for autonomous patients).



Source: This study.

Figure 3-a: Goal Model for SPCS Design: Patient.



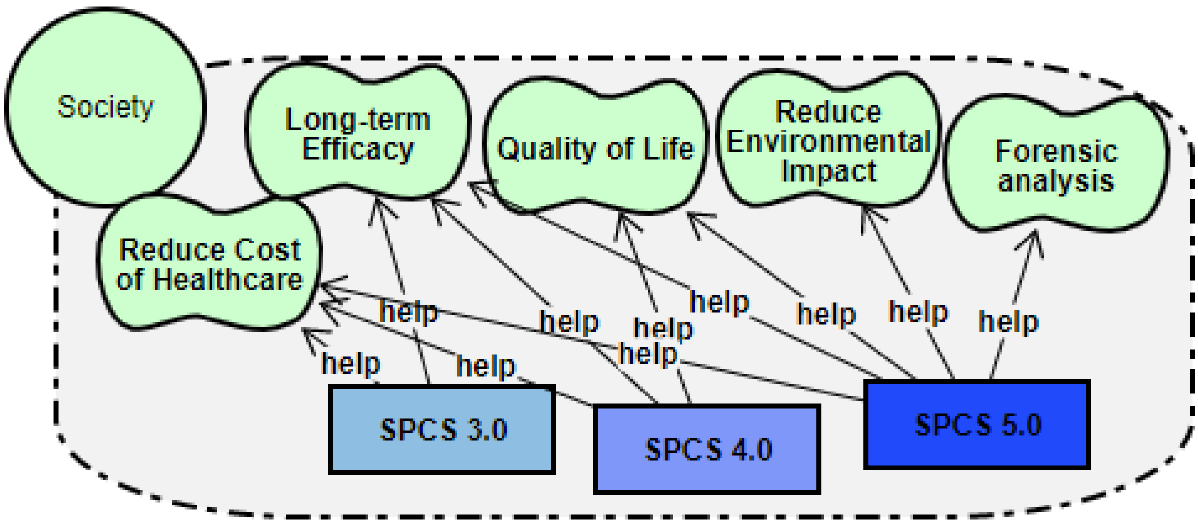
Source: This study.

Figure 3-b: Goal Model for SPCS Design: Carers.

Carers are essential in health service provisions. Therefore, their goals must also be evaluated, namely, the need to monitor inventory (for single patients or multiple patients), ensure both efficiency and safety, and be able to confirm that pharmaceutical care was accomplished according to the requirements / contractual agreements / regulations.

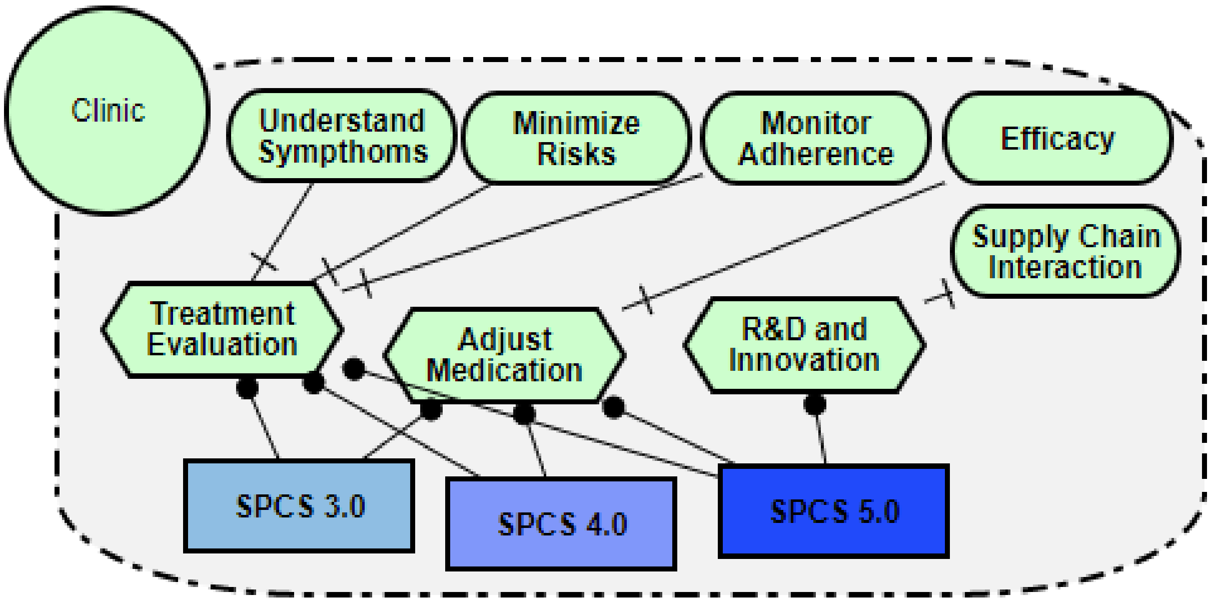
Online information and SMS reminders of SPCS 1.0 can be useful for some patients (e.g., autonomous patients, taking a few drugs) but are less relevant for nursing homes with planed routines. The 100% physical SPCS (2.0) can be important when there are children or potential abuse scenarios (locks) and provide some assistance to carers (monitoring use). Personalization becomes possible with SPCS 3.0 (apps can be tailored to each type of disease) and more advanced features become viable with option 4.0. The SPCS 5.0 adheres to the smart homes trend, extending the physical interaction to cabinets (e.g., RFID, or QR codes to track home inventory and alert, for example, in case of expired or duplicate medicine). The 4.0 generation is also able to project the carers external image of responsibility and quality (e.g., marketing purposes), but only 5.0 can guarantee continuous improvement (big data and AI to learn), fully outsourced inventory management offered by the community pharmacy, and transparency.

Figure 4 outlines the two models of stakeholders that are indirectly related to smart pharmacy services, namely, the society (4-a) that needs to improve health care services using digital technologies, and clinics (4-b) that depend on the quality of medications and on the adherence by patients.



Source: This study.

Figure 4-a: Goal Model for SPCS Design: Society.



Source: This study.

Figure 4-b: Goal Model for SPCS Design: Clinic.

Health 5.0 requires SPCS that are capable to communicate, not merely to inform. Therefore, static SPCS 1.0 or solely physical devices are no longer sufficient. Reminders (SPCS 1.0) cannot confirm that the patient adhere to the medication and, consequently, follows the treatment as required to improve quality of life and minimize costs of non-adherence. The 100% physical pill dispensers (SPCS 2.0) can contribute to reduce risks at home but are limited to support clinic treatments, adjustments, or more advanced data analytics.

SPCS 3.0 is a possible starting point to address both societal and clinical concerns. SPCS 5.0 extends the (4.0) perspective of reducing "errors" and "cost" to the dimensions of collective intelligence, reliable traceability (e.g., forensic analysis), and medicine reuse/polypharmacy feedback. For example, algorithms can be implemented to check for medicines that will probably expire and create a database for social purposes (e.g., drug recycling) that can be shared by the community of health 5.0 adopters. Nevertheless, current adoption of SPCS (even 1.0) is only starting and the pervasiveness of technology at home environments also raises concerns of security and privacy that must be addressed.

Table 1 summarizes the five generations of SPCS according to the key business stakeholders' interests, sourcing model, integration in the pharmacy portfolio, and potential new sources of revenue.

Table 1: SPCS business model.

SPCS	Stakeholders Interest	Sourcing Model	Market Offer	New Source of Revenue
1.0	Community Pharmacy, Patient	IT Development	Service to existing customers	N/A
2.0	Community Pharmacy, Patient, Carer	Supplier	New product	Sales margin
3.0	All	IT Development	New service	N/A
4.0	All	Partnership	New product and service	Integrated offer of pharmacy as a service
5.0	All	Partnership	New product, service, and collaboration opportunities	Integrated offer of pharmacy as a service

Source: This study.

According to Table 1, SPCS 3.0-5.0 can support the needs of multiple pharmacy stakeholders. Two SPCS (1.0 and 3.0) are possible to instantiate with software development (app, reminders integrated in the pharmacy information systems), while SPCS 2.0 requires additional competencies. Our case pharmacy decided to become an intermediary of SPCS 2.0. According to the pharmacists, 100% digital SPCS (1.0 and 3.0) are less interesting – benefits still exist in the form of service improvement or customer retention techniques, but the patient may not be willing to pay for these types of SPCSs. SPCS 4.0 and 5.0 are more difficult to create and may require long term relationships between the pharmacy and smart product developers. Both generations can support continuous contact between the pharmacy and their market (patients or companies), but the 5.0 version can extend the community pharmacy business to the producers of smart home solutions and even capture the attention of new partners such as insurance companies, smart home automation companies, and pharmaceutical industries.

This section presents the results of the design stage, modeling the "*stakeholder goals, motivations, and intentions*" (Samavi et al., 2009) and the role of five generations of smart pharmaceutical care systems for home interventions. Each SPCS has its advantages and drawbacks, as discussed in the next section, but are also a starting point to the instantiation of new smart objects for community pharmacies interested in Health 5.0 (QUT, 2018).

DISCUSSION

The IS literature offered many useful insights to model an ecosystem of wellness for community pharmacy projection. SPCS 2.0, and SPCS 4.0 are two types of IT-based medication management that can be included in the pharmacy portfolio, while SPCSs 1.0 and 3.0 (digital) can support service improvements (a pharmacy investment). All types of SPCSs are important, depending on the target customer segment (e.g., smart robots and apps are popular among active adults). Ultimately, SPCS 5.0 incorporates collective intelligence (Marsh et al., 2011). According to the pharmacy managers, the cost of SPCS 5.0 development does not seem discouraging because it could be shared by governments and industry (the cost of SPCSs 1.0-4.0 is almost entirely supported by the pharmacy, the patient, or the carer) with potential return from advanced data analytics.

Personalization requires flexibility to address the needs of all actors in the ecosystem of wellness. It will be interesting to conduct more action-oriented studies to understand the social changes of digital community pharmacies and propose detailed design guidelines for each SPCSs (e.g., regulatory implications, responsibility, protecting the environment and the resources, ensure system resilience, patient safety). Each sector of the economy will need a vision for collective health intelligence (Marsh et al., 2011). We have modeled the case of community pharmacies where the projection into home health care can evolve in different phases, combining five different IT-based medication management systems.

Community pharmacies need to project their interaction across time and space. IT-based reminders (Singh & Varshney, 2020) are a starting point towards a holistic vision of pharmacy at home. Apps are important but not sufficient to prevent errors and assist users with specific health conditions. Physical materialities are necessary in the home health care and community pharmacies are well positioned to lead the process. Technological companies are valuable partners in this effort that can also be extended to the pharmaceutical industry for real-time monitoring of their products use and interaction.

Study Limitations

First, we have completed a foundational DSR iteration aiming at theoretical (RQ1) and conceptual (RQ2) design outcomes. However, only the instantiation of the five SPCS will allow field evaluation that is already planned according to the framework proposed by Venable, Pries-Heje, and Baskerville (2016). Second, although we have made a comprehensive review of recent IS literature, the selection of keywords and databases poses natural limitations. Third, our model was positively evaluated by the experts to start the SPCS instantiations (SPCS 3.0 will be merged in SPCS 4.0 because a physical device is mandatory to the strategy of our case pharmacy company), but more detailed specifications are necessary (e.g., sensors and actuators). Finally, most of the 31 studies are related to hospitals and devices that are not specific to community pharmacies. Therefore, the models emerge from the research team interpretation and projection to the desired context. Contributions to IT-supported use of medication dispensing in hospitals (e.g., incentives) need to be extended and tested in community pharmacies.

Opportunities for Future Research

The next step of our research is the instantiation of SPCS 1.0 and an IoT prototype for SPCS 2.0. The team will evaluate the impact in the costs and service quality of selected nursing homes. Next, SPCS 4.0 will include human-machine (interaction with the clinic), and machine-machine communication (nursing homes). The pharmacy already assured funding for these DSR iterations and plan to submit an international project proposal for SPCS 5.0: collective intelligence in pharmacy. There are also other opportunities. First, smart pillboxes - even the most advanced models with wearables, are only one form to implement customer retention strategies in community pharmacies. It will be necessary to evaluate the impact of projecting different forms of home intervention and integration of external data, for example, via social networks (Sharma, Whittle, Haghighi, Burstein, & Keen, 2020), to improve decision making and circular economy. Second, SPCS certification will be key. Third, IT providers can find this contribution relevant to create new generations of products that minimize workarounds, improve adherence, and allow integration with third-party solutions, for example, polypharmacy databases and AI algorithms.

CONCLUSION

This paper identifies and frames five smart pharmaceutical care systems. An ecosystem of wellness is modelled for this important and unique health care sector. Design science research (Hevner et al., 2004; vom Brocke & Maedche, 2019) is the selected research approach to produce models tailored to a specific set of problems in pharmaceutical setting: project community pharmacies into home health care. The models adopt i* language (Samavi et al., 2009; Yu, 1997) and are the result of our contacts with the community pharmacy and a literature review (Webster & Watson, 2002) of 31 IS publications.

The journey to pharmacotherapy instantiated with smart devices should aim at human-centered health care ecosystems tailored for the needs of each patient, while contributing to health collective intelligence and sustainability challenges. The IS research provided a valuable starting point to incorporate Health 5.0 in pharmacy setting. Community pharmacies are key players in modern health care systems and there are already interesting examples of digital technology adoption. However, digital transformation will require to go *beyond the reminder* (Gatwood et al., 2019) and create new smart solutions to project community pharmacies into home health care.

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