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Online geographic information systems for improving health planning practice: lessons learned from the case study of Logan-Beaudesert, Australia

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ABSTRACT

This study examines the impact of utilising a Decision Support System (DSS) in a practical health planning study. Specifically, it presents a real-world case of a community-based initiative aiming to improve overall public health outcomes. Previous studies have emphasised that because of a lack of effective information, systems and an absence of frameworks for making informed decisions in health planning, it has become imperative to develop innovative approaches and methods in health planning practice. Online Geographical Information Systems (GIS) has been suggested as one of the innovative methods that will inform decision-makers and improve the overall health planning process. However, a number of gaps in knowledge have been identified within health planning practice: lack of methods to develop these tools in a collaborative manner; lack of capacity to use the GIS application among health decision-makers perspectives, and lack of understanding about the potential impact of such systems on users.

This study addresses the abovementioned gaps and introduces an online GIS-based Health Decision Support System (HDSS), which has been developed to improve collaborative health planning in the Logan-Beaudesert region of Queensland, Australia. The study demonstrates a participatory and iterative approach undertaken to design and develop the HDSS. It then explores the perceived user satisfaction and impact of the tool on a selected group of health decision makers. Finally, it illustrates how decision-making processes have changed since its implementation. The overall findings suggest that the online GIS-based HDSS is an effective tool, which has the potential to play an important role in the future in terms of improving local community health planning practice. However, the findings also indicate that decision-making processes are not merely informed by using the HDSS tool. Instead, they seem to enhance the overall sense of collaboration in health planning practice. Thus, to support the Healthy Cities approach, communities will need to encourage decision-making based on the use of evidence, participation and consensus, which subsequently transfers into informed actions.

INTRODUCTION

In the last few decades, the focus on building healthy communities has grown significantly (Ashton, 2009). This trend is the result of an international initiative to create the broad conditions that contribute to health rather than simply to continue to treat burgeoning levels of disease (Otgaar et al. 2011). As part of those efforts, the process of developing healthy communities has become an important focus for health planners (Otgaar et al. 2011). There is growing evidence that new approaches to planning are required, based on timely use of local information, collaborative health-planning, and the engagement of the communities in local decision-making (Murray, 2006; Scotch & Parmanto, 2006; Ashton, 2009; Kazada et al., 2009). However, there is little research in relation to the methods that support this type of responsive, local, collaborative and consultative approach to health planning (Northridge et al., 2003).

Some research justifies the use of Decision Support Systems (DSS) in planning for healthy communities in that they have been found to increase collaboration between stakeholders and communities, improve the accuracy and quality of the decision making process, and improve the availability of data and information for health decision-makers (Nobre et al., 1997; Cromley & McLafferty, 2003; Waring et al., 2005). Geographical Information Systems (GIS) has been suggested as an innovative method by which to implement DSS. Furthermore, literature has indicated that online environments have a positive impact on decision-making by enabling access by a broader audience (Kingston et al., 2001).

However, only limited research has been conducted about how to implement online DSS or evaluating its impact on decision-makers. Previous studies have emphasised that due to the lack of effective information, systems and an absence of frameworks for making informed decisions in health planning, it has become imperative to develop innovative approaches to, and methods for, health planning practice (Higgs & Gould 2001). Researchers have identified a number of gaps in our knowledge (Kazada et al., 2009; National Health and Hospitals Reform Commission, 2008), including, a lack of methods to develop DSS tools in a collaborative manner; lack of knowledge about GIS applications among health decision-makers; and limited understanding about the potential impact of DSS on decision-making processes. Thus, this study focuses on developing a DSS, and a method of evaluating its impact on health planners and decision-makers. Specifically, the study examines the development and implementation process, the usage and response to the intervention, and its impact on decision-making processes in a particular case study, the Logan-Beaudesert Health Coalition.

In response to the growing level of health risk factors in the last five years in the Logan-Beaudesert area, it was identified that the cost of chronic disease to society remains significant and current management and planning methods do not appear to be having sufficient impact. Consequently, collaborative planning was suggested as a method for improving outcomes. As a result, the Logan Beaudesert Health Coalition (LBHC) was established in 2006. The LBHC aims to deliver innovative services that focus on broader determinants of health framework (i.e., Schulz & Northridge, 2004) to reduce risk factors, thus reducing the incidence of chronic disease in the area (Kendall et al., 2007). However, it quickly became clear that the LBHC did not have access to new methods or tools for undertaking collaborative planning.

This study focused on the development, implementation and evaluation of a practical method for decision-makers to participate in collaborative health planning that can encourage the creation of the local conditions necessary to promote health in their region. It culminated in an innovative tool (i.e., HDSS[1]) that aimed to enhance collaborative mechanisms by facilitating decision-making based on evidence, participation and consensus.

USE OF EVIDENCE, PARTICIPATION AND CONSENSUS: THE WAY HEALTHY COMMUNITIES MAKE DECISIONS

Although more than 20 years have passed since the initiation of the Healthy Cities movement, there is some evidence that it has not yet achieved its full potential (Ashton, 2009). Recently, the founder of the Healthy Cities movement (i.e., Kickbusch) called for a renewal of the commitment (Ashton, 2009) on the basis that the urban agenda has become even more relevant. Trends such as rapid urbanisation, unsustainable development, and global warming have highlighted the necessity of a focus on urban health. Towns, cities and communities committed to promoting health and sustainability now face two key challenges: how to move health promotion from the margins to the mainstream; and how to integrate multiple forms of information and sectors in such a way that planning can contribute to the development of Healthy Cities (Dooris, 1999).

The promotion of 'healthy' public policy has been noted as being central to the Healthy Cities approach (Flynn, 1996). However, the Healthy Cities concept necessitates planning that moves beyond current approaches. It requires planning that focuses on the whole community and the promotion of health, rather than being confined to the development of responses to one or more specific health problems based on a narrow body of knowledge. The Healthy Cities concept is based on models of city governance in which public authorities recognise the need to work with and support a range of actors who are either fully committed to health, or play a significant role in contributing to the conditions that promote health (WHO, 1999). The Healthy Cities concept suggested the need to restructure health decision-making processes, shifting power to the local level, and basing decisions on a localised but comprehensive body of knowledge. Planning for Healthy Cities requires collaboration between different groups in the community that can contribute to health-promoting conditions, such as local government, community organisations, universities, private organisations, and health services. The literature suggests that stronger collaborations between urban planners and public health practitioners may prove effective in designing and planning for Healthy Cities (Northridge et al., 2003). Given this, the process of decision-making in health planning should be based on a structured model that draws together multiple forms of knowledge and increases the possibility of coherent localised and responsive solutions (Scotch & Parmanto, 2006).

[1] HDSS denotes the name of the system prototype, whereas DSS is a term which represents the decision support systems concept

Flynn (1996) suggests the following steps for developing Healthy Cities: establishing a broad structure for the community, encouraging community participation, assessing community needs, establishing priorities and strategic plans, soliciting political support, taking local action, and evaluating progress. Despite the presence of these guidelines for creating Healthy Cities, there is little consensus about how health planning can best be practiced (Duhl & Sanchez, 1999). Thus, to support the Healthy Cities approach, communities will need to encourage decision-making based on the use of evidence, participation and consensus, which subsequently transfers into actions.

POTENTIAL OUTCOMES OF DECISION SUPPORT SYSTEMS IN HEALTH PLANNING

The role of DSS in health planning practice continues to evolve, with the application of this technology being an important step towards better understanding of public health issues and their inherent complexities (Waring et al., 2005). The literature identifies a number of potential outcomes of DSS, including increased collaboration or participation, trust, increased satisfaction in decision-making, user satisfaction, construction of knowledge, and increased use of evidence in decision-making processes (Igbaria & Guimaraes, 1994). Even if the system (i.e., DSS) does not address all users' needs, the fact that users have played an important role in designing the system and its constant refinement process, contributes to the overall notion of collaboration reflected by participants (Omar & Lascu 1993; Murray, 2006).

DSS is perceived to have a role in a number of settings for health planning. These include identifying service health barriers and health needs for particular populations or regions, supporting strategies to address gaps, facilitating multi-directional communication channels, and re-affirming transparent communication and decision-making processes (Phillips et al., 2000). To encourage community engagement and reduce health inequalities, DSS may be used as an outreach vehicle for community-based public health empowerment. In turn, this "may help our understanding of the complex relationship between socioeconomic factors and health status" (Phillips et al., 2000, p. 976).

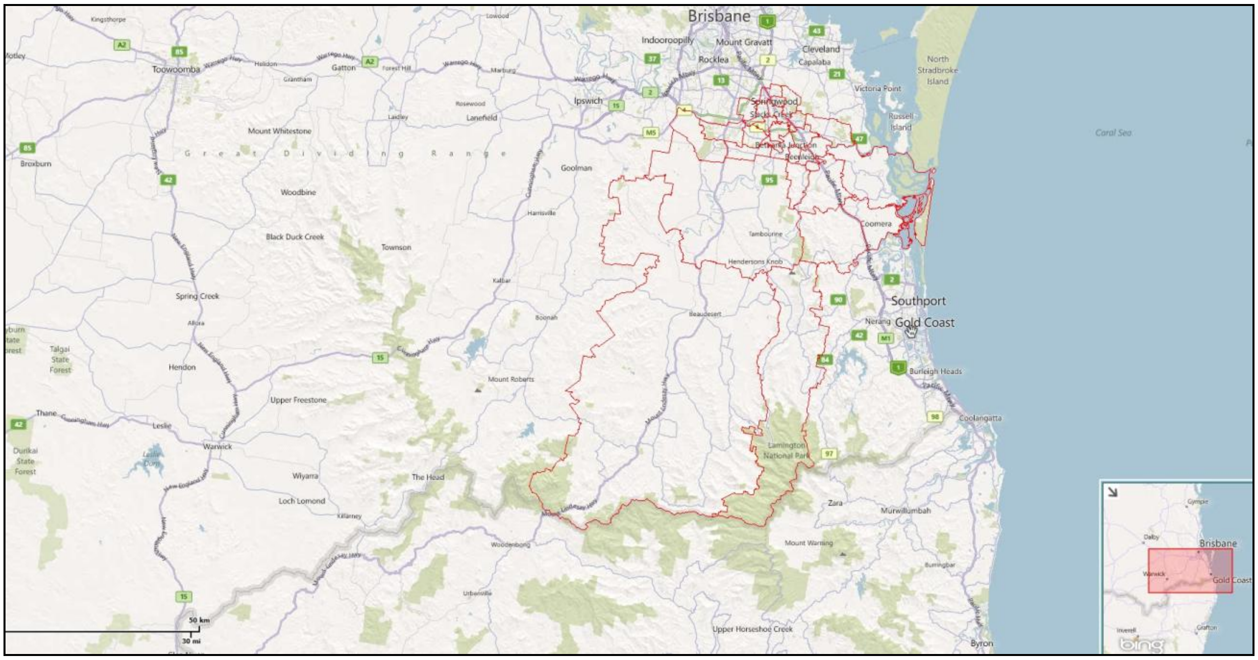
One contemporary method for implementing a DSS is to use GIS. Research has indicated that GIS has the potential to be used in a range of decision-making tasks. The use of analysis and visualisation capacities (e.g., spatial aspect) within GIS provides an opportunity to use this tool to create an innovative DSS. For example, through GIS, users can visualise the effects of healthcare delivery strategies (Higgs & Gould, 2001). If GIS is to be integrated into the decision-making mechanism, then several prospective improvements could be accrued, particularly in the context of the local government public health sector.

Significantly, research indicates that online environments have a positive impact on decision-making (Kingston et al., 2001).The ultimate technical goal of online DSS is to ensure that information is made available for end-users to perform analyses and represent their own results within the system (Yigitcanlar & Gudes 2008). Contrary to static presentations, online information becomes dynamic when users are allowed to access or interact with the database from their own computer (Croner, 2003). The number of online DSS is increasing rapidly as the technology becomes more readily available and more industries realise their potential (Su et al., 2000). Indeed, Richards et al. (1999) emphasized that the application of GIS techniques in an online DSS allows decision-makers to ask questions of maps and to quickly, clearly, and convincingly show the results of complex analyses. However, unless health planning is also practiced in a collaborative manner, simply increasing access to effective information through DSS may not be sufficient to generate the type of decision-making that can lead to healthy cities.

CASE STUDY

The LBHC partnership was established to address the growing level of chronic disease risk factors in the Logan-Beaudesert region of Queensland. This initiative aimed to enhance existing services and infrastructure, establish formal partnerships, improve existing resources, and implement additional services and strategies. Its ultimate goal was to improve the health capacity of the region at multiple levels through enhanced and responsive localised planning. The LBHC has a central committee (LBHC board), which oversees six health programs, each with an advisory group drawn from the relevant sector. Each program addresses a specific area identified as needing attention in the region, early childhood (0 to 8 years of age), multicultural health, the prevention and management of existing chronic diseases, the integration between general practices and acute settings, efficient health information management, and health promotion. By providing recommendations and information, the programs assist the LBHC board to make decisions and develop policies and strategies. The LBHC board coordinates and directs the coalition as a whole. The Queensland State Government funds the LBHC, and has given its board the mandate to modify, alter or adapt any of the current programs in response to evidence and performance data, with the scope to design and implement new health initiatives as required. The decisions of the LBHC board are reflected back to the six health programs for implementation. Thus, the LBHC was an ideal platform for designing, implementing and evaluating the DSS, arising from the need to help LBHC board members make better decisions that would contribute to the development of a healthy communities in the Logan-Beaudesert area. Figure 1 illustrates the Area of Interest (AOI).

Figure 1. Map of the Logan Beaudesert region



METHOD

PARTICIPATORY ACTION RESEARCH

Collaborative planning approaches are increasingly being advocated and implemented in Healthy Cities initiatives due to the demonstrated benefits of these approaches (Murray, 2006). One approach for facilitating collaboration that has been used for some time in many fields is Participatory Action Research (PAR). PAR is being increasingly used as an overarching name for an orientation toward research practice that places the researcher in the position of co-learner, and puts a strong emphasis on input from participants or end-users as well as the ongoing translation of research findings into action (Minkler, 2000). This approach has gained attention in the health planning field, particularly in the public health context (Minkler & Wallerstein, 2003). One of the most important characteristics of PAR is the fact that participants or stakeholders, whose lives are affected by the research initiative, take an active role in its design, implementation and evaluation. It was anticipated that the application of PAR to the development, implementation and evaluation of the HDSS tool would predispose the LBHC board to engage in collaborative processes, actively participate in decisions and take collective responsibility for the outcome of the study. By exposing the board members to the DSS in this manner, it was hypothesised that these same qualities might be reflected in their decision-making once the DSS was established (i.e., use of evidence, participation and consensus in decision-making).

The PAR approach also addressed an important requirement of the DSS literature, namely flexibility. Specifically, research has emphasized that one of the key requirements of a collaboration-based system is its flexibility to adapt to users' needs, thereby increasing planning efficiency. Thus, by applying PAR, the DSS was more likely to respond appropriately to users' needs, resulting in greater engagement in the long-term and, presumably, better decision-making. There is evidence in the literature that decision-making satisfaction in the context of a decision support system is likely to be associated with the perceived quality of the system, information and presentation. Indeed, the literature emphasises that the best predictor of effective decision-making is satisfaction with one's decision-making (Bharati & Chaudhury, 2004).

Finally, PAR enabled the DSS to be applicable to the local circumstances. The DSS literature has emphasized the fact that health planners do not have at hand the local knowledge needed to determine the type of information required for good decisions (Gudes et al., 2010). However, it has also highlighted that the development of information frameworks is not a simple matter. As Flynn (1996) has argued, every community is unique, with different physical, social, political and cultural contexts that must be understood in the planning process. For this reason, health planners must develop a thorough understanding of the community health profile and the structural features that influence its health. The framework used to structure information should organise that information in a way that directs the attention of decision-makers to the entire range of conditions influencing health (Gudes et al., 2010). By using PAR, collective agreement was reached on a suitable framework (i.e., Schulz and Northridge, 2004) to guide the GIS data collection efforts. In addition, the participants were able to prioritize each layer of information according to their local requirements.

Participatory Action Research Intervention

The PAR design incorporated both quantitative and qualitative techniques of data collection and analysis to engage board members in the design, development and implementation of the HDSS. Our PAR approach was implemented in three cycles, namely: PAR 1 (i.e., Introduction Stage); PAR 2 (i.e., Interaction Stage), and PAR 3 (i.e., Trialling Stage). Figure 2 illustrates the PAR Intervention.

PAR cycle 1: Introduction Stage

The Introduction Stage was associated with the early days of the study, where the concept of GIS was first introduced to LBHC board members and included several introductory presentations to raise their awareness. The PAR intervention phase commenced with a series of GIS introductory presentations to the LBHC board and other advisory groups that took place in March and April 2010. The primary purpose of this cycle was to raise awareness of the GIS and DSS as tools to support decision-making. To raise the awareness of the LBHC board, this cycle included a number of demonstrations of GIS, as well as discussion about its impact and potential application to local decision-making.

PAR cycle 2: Interaction Stage

The Interaction Stage was associated with the period of time between the Introduction Stage and Trialling Stage, where LBHC board members were engaged (e.g., via consultation meetings and workshops) in the collaborative process of designing and developing the HDSS.

In line with the recommendation of Maeng and Nedovic-Budic (2010), PAR 2 consisted of a series of consultation meetings to obtain input from end-users about the prospective GIS information items, its features and functionality, and health scenarios (i.e., workflows) to be included in the HDSS. To assist in identifying the relevance and urgency of including particular types of information in the HDSS prototype, a Data Priority Survey was conducted with the HDSS end-users (i.e., LBHC board members). The information obtained in this survey was based on the Schulz and Northridge's (2004) framework which was agreed by LBHC board members as being a suitable foundation for the management of information. The data collected from the survey was categorised into three groups according to the level of priority (1 = essential now; 2 = could be included in next phase; and 3 = not necessary at all). The total score was calculated for each item across the board members (See Appendix 1), which was then used to determine the final level of priority. This ranking system made it possible to ascertain which GIS information items to include in the HDSS prototype. The data was presented back to the board members and the information items which were not considered to be essential were excluded from the current version of the system.

In addition to selecting information items, board members participated in discussions about the inclusion of features and functionality in the HDSS. The LBHC members were provided with examples of potential features and functionality using demonstrations of other GIS applications. A discussion was held about each feature, and LBHC board members were asked to determine its inclusion and priority until a final list was constructed.

Based on the board's decisions, a list of workflows was suggested. HDSS users were guided through a series of structured workflows that identify the subsequent spatial output that might be generated, based on a group of predefined information items. The workflows were designed to demonstrate functional capability of the proposed HDSS prototype, based on real health data. LBHC board members commented on the suggested workflows, in particular, what data (i.e., GIS layers) to include in each workflow. Thorough discussion was facilitated to determine the level of priority of specific data (i.e., GIS layers) within the proposed HDSS prototype to support their day-to-day planning and decision-making practice. After a fruitful discussion, two workflows were carefully chosen to be part of the HDSS scope. The revised workflows were disseminated among the LBHC board members for received final endorsement prior to the engagement of a web-based GIS developer who created the prototype. In summary, throughout the PAR Cycle 2 (i.e., Interaction Stage), feedback and information was collected and analysed collectively providing an invaluable opportunity to design and develop the HDSS in a collaborative manner.

PAR cycle 3: Trialling Stage

The Trialling Stage encompassed a period of three months from when the HDSS prototype was officially deployed (March, 2011), and LBHC board members began using the system. The primary purpose of this stage was to implement and trial the system, while simultaneously collecting evidence about the extent of usage and degree of user satisfaction. In keeping with the PAR method, feedback collected during consultations and training sessions was incorporated into the prototype during this cycle. To collect usage and satisfaction information, two instruments were used:

- Google Analytics script to monitor the number of unique visits, views, and the average time users used the HDSS; and

- A User Satisfaction survey to explore and understand the experiences of the LBHC board members in using the HDSS. This survey was also an important tool for continual refinement of the system.

Omar and Lascu (1993) identify a five-construct (23 items) scale for measuring user satisfaction that has been validated and used in a range of contexts. The survey consisted of the following constructs: information quality (characteristics of information in terms of currency, accuracy, relevance, flexibility, ease of use and access - 9 items), planning (characteristics of planning, whether the system was developed as part of a broader planning agenda - 6 items), staff and services (staff competence and the quality of services supporting the system - 3 items), system support for decision-making (ability of the information system to support decision-making processes - 2 items), and user involvement (attributes that generate and encourages user involvement and participation - 3 items).

Data Analysis

The User Satisfaction survey was utilised to identify the perceived levels of HDSS satisfaction experienced by LBHC board members. Given that only 17 LBHC board members participated in this survey, the data was used descriptively to improve the HDSS in accordance with the PAR method (i.e., as part of PAR Cycle 3). Derived from Omar and Lascu’s (1993) recommendations, 23 items were identified. These items were associated with five constructs: Information quality, Planning, Staff and services, Systems supports for decision-making, and User involvement. The items were then divided into two main groups: importance and performance. As suggested by Omar and Lascu (1993), the 23 performance items were multiplied by the importance items, yielding ‘weighted performance items’. To measure the statistical dependence between each of Omar and Lascu (1993) five constructs and a broad question asking respondents to rate their overall level of satisfaction with the HDSS (See Item 24 in the User Satisfaction survey, Appendix 4), Spearman's correlation test was utilised. Therefore, the 23 items were cumulated to the five constructs, and were then correlated with the overall satisfaction construct. This has revealed which construct attained the highest level of correlation with the overall satisfaction construct.

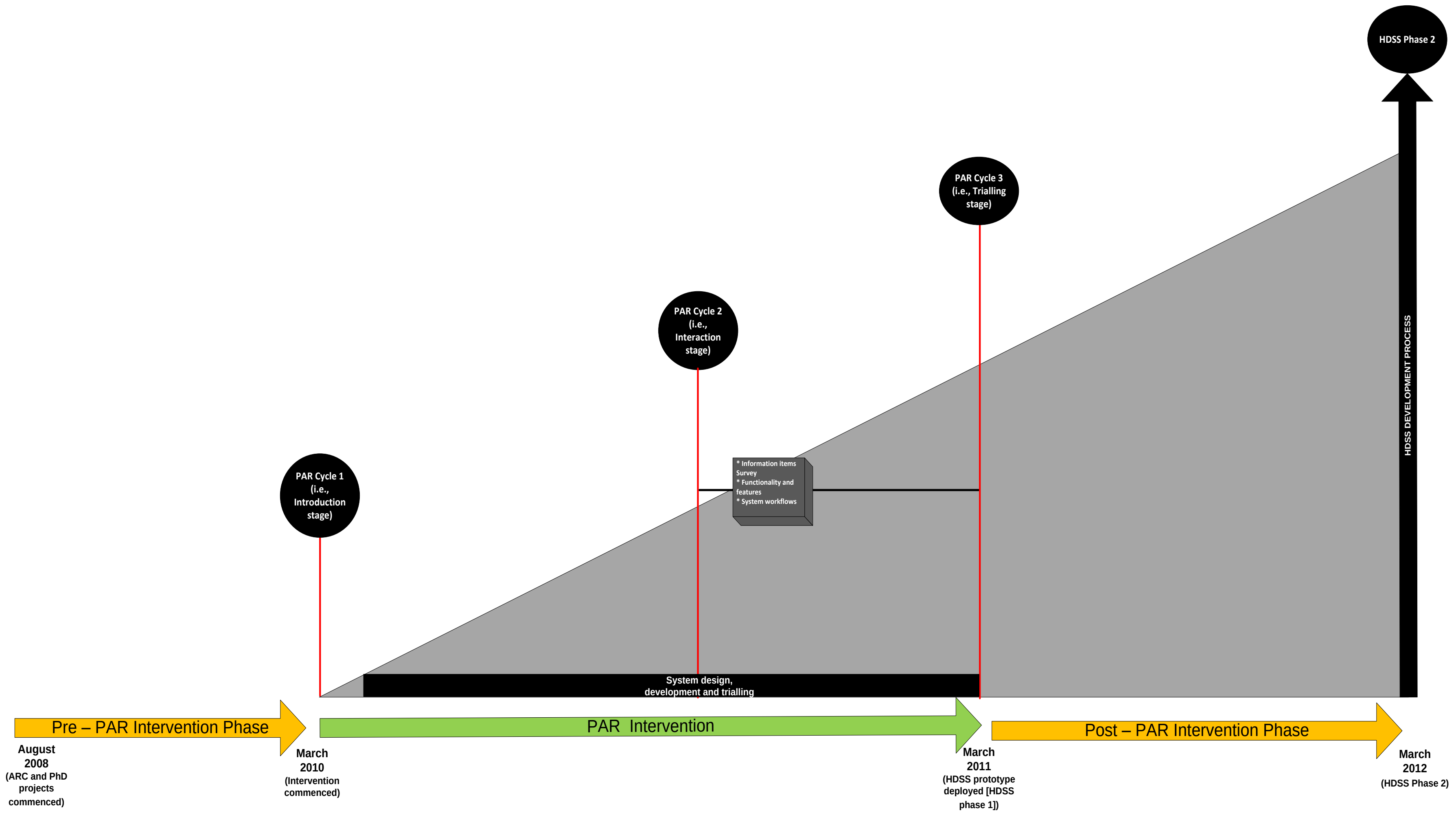


Figure 2. PAR Intervention

Decision-making impact evaluation

To understand the potential role of HDSS in improving decision-making processes, observational data was collected. This method was employed prior and subsequent to the PAR intervention. Two waves of data collection were used, one prior to the beginning of the PAR intervention and one following completion of the PAR intervention. This, in turn, helped exploration and understanding of the decision-making experiences of the LBHC board members.

Observational data

LBHC board meetings were recorded and transcribed from the outset of this study until the establishment of the HDSS prototype. Our data collection activities involved listening to these LBHC board meetings as well as reading through minutes of meetings and summary notes. Data collected was used to measure and analyse the actual decision-making of the LBHC board members. To identify trends in the number and, more importantly, the nature of the decisions made by the LBHC board due to the HDSS intervention, two meetings were selected in each year as the sample, commencing from the outset of this study (i.e., 2008) to the Post-Intervention Phase (i.e., 2010 and 2011). When trying to examine whether any change has occurred in the way actual decisions were made, analysed meetings were clustered into two groups. Specifically, four analysed meetings were associated with the period before the intervention (i.e., Pre-Intervention Phase) and four meetings after (i.e., Post-Intervention Phase). The scale embraced the following dimensions: use of evidence, participation, and consensus. The response rate was determined by the researcher's observation and included the following rates: limited use (e.g., limited use of evidence in the actual decision), moderate use, and high use.

FINDINGS

PAR CYCLE 1: INTRODUCTION STAGE

Although the GIS concept was introduced informally on several occasions throughout 2008-2009, it was formally presented to the LBHC board members at a meeting in April 2010 after baseline data has been collected. During this meeting, details and a variety of maps were presented to explain and clarify the potential role of GIS in health planning. LBHC board members were encouraged to think about their required data needs. In one of these presentations, a participant stated: ***"we need to know what information should be included in the system".*** As a result of the initial GIS interaction, some LBHC board members requested additional GIS information. During the presentations, one participant noted: ***"Yes I agree this is an important marker in the development of evidence used in the LBHC***". These reactions implied an evolving awareness of the use of GIS in the LBHC board's decision-making processes.

PAR CYCLE 2: INTERACTION STAGE

During the Interaction Stage, the LBHC board members collaboratively defined the key components for designing the HDSS: Information items, features and functionality, and health scenarios. The following provides more information about the instruments used to design and develop the system. Appendix 1 presents the main findings from the Information Items survey. The findings indicate that the most essential information items included: socioeconomic, demographic, public transportation, shops, roads, recreation, community facilities, education facilities, health facilities and disease data. Two data items (health behaviours and hospital admissions) were indicated as being essential, but due to difficulties accessing these datasets, this data was not used in the HDSS prototype. Appendix 2 presents the final list of selected features and functions which were included in the HDSS prototype, along with a description of the purpose of each. Based on the information items selected and the defined features and functionality, the LBHC board members were consulted to articulate the details of the two workflows of the HDSS prototype (i.e., proximity and accessibility to health facilities). One of the designated workflows is illustrated in Appendix 3.

PAR CYCLE 3: TRIALLING STAGE

During the Trialling Stage we used two instruments to understand the extent of usage and degree of satisfaction the HDSS attained. The first instrument was Google Analytics script which monitored the systems logs. Findings indicate that throughout the three months of trialling the system, it was visited more than 100 times by 33 unique users (excluding the admin group). On average, users spent four minutes in using the system. Also, evidence indicates that some users were using the systems from different computers (e.g., office, home etc.). Given that only 17 LBHC board members had access to the system and the time of implementation was short (three months), the extent of usage was considered to be good.

As for the degree of satisfaction, we utilised a User Satisfaction survey to understand user's experiences with the system. Twelve LBHC board members completed the questionnaire, and given that there were approximately 17 HDSS users at the time, this response rate was considered to be good (i.e., 70%). As suggested by Omar and Lascu (1993), 23 items were grouped into two major groups: importance items and performance items. As for the importance constructs, findings indicate that System supports for decision-making in addition to Staff and services constructs rated the highest score (i.e., 6.4), whereas the User involvement construct yielded the lowest score (i.e., 5.6). In the Performance constructs, Staff and services rated the highest with a score of 6.1, while System supports for decision-making and Planning constructs rated the lowest (i.e., 5.0 and 4.9 respectively).

Derived from Omar and Lascu's (1993) recommendations, the five Performance constructs (Omar & Lascu, 1993, p. 8; Table 3.2) were multiplied by the Importance constructs to yield 'weighted performance constructs'. The weighted performance constructs were then correlated to the Overall satisfaction variable (See item 24 in the User Satisfaction survey, Appendix 4). The Spearman's correlation test shows that Information quality and System supports for decision-making constructs attained the highest level of correlation (0.62 and 0.59 respectively) with the Overall satisfaction construct. The Spearman's correlation test shows also that this correlation was significant. The Planning construct was rated 0.37 with trending towards significance. User involvement attained the lowest level of correlation (i.e., 0.28); however, this score was not significant. Interestingly, although the Staff and services construct yielded the highest weighted mean (i.e., 39.7), the Spearman's correlation test shows it was less correlated (i.e., 0.37) to the Satisfaction construct. However, this was found to be non-significant.

In summary, the quantitative and qualitative findings of the User Satisfaction survey confirm that overall there was high level of satisfaction with the HDSS (Mean=5.8, SD=1.0, N=12) by its users. Findings indicate that items associated with system supports for decision-making and the information quality constructs were highly important to participants. However, these constructs were only rated moderately by HDSS users. This was also supported by the correlation findings which point out that system supports for decision-making and information quality planning were perceived as important elements for the overall satisfaction of HDSS.

OBSERVATIONAL FINDINGS

The actual LBHC decisions were aligned with two phases (i.e., Pre PAR Intervention Phase and Post PAR Intervention Phase). Once decisions were evaluated, it was possible to examine whether there was any distinction between the two phases. The Pre PAR Intervention Phase (four meetings) included seven decisions. Five of these decisions were characterised by limited use of evidence, six decisions were characterised by limited level of participation, and five decisions were characterised by a low level of consensus. Thus, only a few decisions were characterised by moderate or high levels in any of the key dimensions. In the Post PAR Intervention Phase (four meetings), 14 decisions were observed. Table 1 summarises the Pre and Post PAR Intervention decisions by key dimensions. The findings indicate that ten of these decisions were characterised by moderate use of evidence, ten decisions were characterised by high level of participation and 11 decisions were characterised by high level of consensus. Furthermore, only three decisions were characterised by limited level of evidence.

Furthermore, findings show that more decisions were characterised by either a moderate or a high level in any of the key dimensions in the Post PAR Intervention Phase. This implies that the decision-making process of the board changed over time towards greater use of evidence, participation and consensus. It was observed that the LBHC board has been through a cultural change. For instance, less negative comments were observed in the Post PAR Intervention Phase about the board's practice and the fact that decisions were made out of meetings. To support this, more positive comments were observed in the LBHC board meetings about the level and thoroughness of discussions. For instance, one of the participants noted: "***There was a cultural shift in the LBHC",*** while another participant stated: "***I think now, there is a greater level of confidence in the board".*** Thus, the evidence suggests a shift in the way discussions and decisions were made throughout the study.

Table 1. Pre and Post PAR Intervention Phases summary of decisions by key dimensions

Pre PAR Intervention Phase	**Use of evidence**	**Level of participation**	**Level of consensus**
Limited level	5/7	6/7	5/7
Moderate level	1/7	-----	1/7
High level	1/7	1/7	1/7
Post PAR Intervention Phase	**Use of evidence**	**Level of participation**	**Level of consensus**
Limited level	3/14	-----	-----
Moderate level	10/14	4/14	3/14
High level	1/14	10/14	11/14

DISCUSSION AND CONCLUSIONS

This study suggested a collaborative-based planning method (i.e., PAR Intervention) to design the HDSS. Data were collected with a PAR approach that informed the development and conceptualisation of the HDSS. The PAR approach consisted of three cycles that were executed:

- PAR cycle 1: Introduction Stage;
- PAR cycle 2: Interaction Stage; and
- PAR cycle 3: Trialling Stage.

In PAR cycle 1 the primary purpose was to raise awareness of the GIS concept for decision-making, and that was implemented by a series of GIS introductory presentations with the LBHC board members. In PAR cycle 2 we scoped the HDSS and its technical requirements in a collaborative manner. While in PAR cycle 3 the system was deployed and trialled for three months by LBHC board members. Findings indicate that although the system was designed in a collaborative manner and in accordance with the LBHC board needs, substantial development and expansion was still required. This was particularly pertinent in terms of information items, which were likely to improve HDSS application in LBHC board's day-to-day role. Furthermore, findings suggest that more analytical tools are required to improve the use of evidence in decision-making and make the HDSS more applicable.

As for the decision-making impact, the PAR Intervention was embedded within a longitudinal Pre and Post research design aimed at determining the impact of the PAR intervention on decision-making processes within the LBHC. Two waves of data collection were used - one prior to the beginning of the PAR intervention and one following completion of the PAR intervention. Findings show that more decisions were characterised by either a moderate or high level of participation, consensus, and use of evidence in the Post PAR Intervention Phase. This implies that the decision-making process of the board and LBHC changed and improved over time. Further, evidence suggests that knowledge was created by the PAR Intervention rather than just as a result of the HDSS technical design and development process. For example, findings show that the process helped to create the notion of 'collaboration' in the planning process. This, in turn, positively contributed to the overall impact of the HDSS, as LBHC participants sensed they were contributing in the planning process and played an important role in developing the system. In addition, evidence suggests that the board had gone through a cultural shift throughout the study. Therefore, it is concluded that HDSS can produce the type of information and effectiveness that facilitates collaborative planning. Thus, it improved the way decisions were made in terms of: use of evidence, consensus, and participation. However, some questions were raised about testing the HDSS framework in the longer term, and clarifying whether it could achieve a positive impact, not only at the decision-making processes level, but also in the long term Health Outcomes level in the community (see the framework suggested by Gudes et al. 2010, p. 26). These questions remain unanswered and form the basis of future study.

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Appendices

Appendix 1. Summary of information items survey

Please rate your level of requirement for each of the following information items. For example, tick the cell that best represents how important you think each type of information is for inclusion in the HDSS prototype. Please add any comments you think may be relevant to our decisions about information	**This group of information items is essential now N (%)**	**This group of information items could be included in phase 2 of the HDSS N (%)**	**This group of information items is not necessary at all N (%)**
Demographic (Population, Projected population (2007-2027), Mortality rate, Indigenous, Multicultural (Clustered Nationalities), Nationalities and Population density)	10 (100%)	—	—
Socio Economic (SEIFA Index, Employment and Unemployment rate, Income average and financial resources, Internet access, Education, Businesses by Industry Division, and Public Housing	9 (90%)	1 (10%)	—
Sustainable Built and Natural Environments (Environmental hazards, Biodiversity and Contaminated land)	2 (20%)	8 (80%)	—
Terrain (Aerial images, Topography and Contour)	1 (10%)	7 (70%)	2 (20%)
Public transportation (Bus stations, Bus routes, Railway Stations and Railway routes)	10 (100%)	—	—
Recreation (Parks, City swimming pools, Sporting facilities and Cycling paths)	10 (100%)	—	—
Emergency (Police, Fire station and Ambulance station)	4 (40%)	6 (60%)	—
Shops (Shopping centres, Fast food outlets)	8 (80%)	2 (20%)	—
Roads (Major roads and Streets)	9 (90%)	1 (10%)	—
Health facilities (Pharmacies, Aged care, Breast Screen, Child Health, Medical Services, Mental health, Oral health, Public hospitals, Private hospitals, GP's and Medicare)	10 (100%)		—
Education Facilities (Child community Services, Higher education, Libraries, Schools, Special education, State Pre School, Youth clubs, Play groups and Universities / TAFE)	9 (90%)	1 (10%)	—
Community facilities (Non profit organisations, Community centres, Community facilities, Community Welfare, Employment services, Religious institutions, Services clubs, Social clubs Sporting clubs, Youth clubs, Schools, State, Non-state schools and Centre link offices)	9 (90%)	1 (10%)	—

*** **Health Behaviours** (Obesity [BMI])	10 (100%)	—	—
*** **Hospital admissions** (summary by year of the total number of separations by SLA for the following admitted diseases: Depression, Cardiovascular, Diabetes and Asthma)	10 (100%)	—	—
Health data (Avoidable mortality, Chronic disease, Composite indicators chronic diseases, Health Risk Factors, Premature mortality by selected cause, Private health insurance and Self assessed health)	8 (80%)	—	2 (20%)

Appendix 2. Features and functionalities selected by LBHC board members for the HDSS prototype

Feature / Function	Purpose
User Login	Screen for user to log into system
Map Navigation	Basic Map Navigation, including zooming and panning
Base Map/ Imagery View	Ability to select aerial imagery or street maps as a base view
Layers	Ability to view health and demographic layers of the LBHC
Layer list	Ability to turn layers on or off
Identify attributes	Ability to view details of attributes found at a certain location
Online Help	Accessibility to text on help notes for using the system
Print Map	Ability to print a map
Map Legend	Ability to view an image indicating symbology used in the map
Layer Metadata	Ability to view metadata (i.e., data on data) for each of the layers used in the system
Spatial Bookmarks	Ability to store the extent of a view for quick zoom in
Simple Search	Ability to undertake a simple geographical search of a name field on two spatial layers: SLAs (Statistical Local Areas) and community health centres
Redlining and Measurements	Ability to draw points, lines, polygons and text on the map
User Feedback	Ability for users to submit feedback regarding data set issues, updates or any other requirements of the system.
Accessibility analysis	Ability to compute the service area of two layers (public hospitals and GPs) based on driving or pedestrian travel time
Proximity function	Ability to find features in specified layers (public hospitals and GPs) within a specified buffer distance of a point entered by the user

Appendix 3. Proposed workflow for accessibility function

Workflow Name	Accessibility Function
Description	The literature emphasises that accessibility to health facilities has been identified as a key determinant of health
Objective	To test the effect of travel time to health facilities
Suggested End Users	LBHC members, Logan and Scenic Rim planners
Anticipated Outcome	To Identify gaps in the provision of health facilities in the community
Suggested Workflow	1. User logs into HDSS Prototype. 2. A map view is presented showing SLA boundary suburb names. 3. The user zooms in to a specific area. 4. The user selects a button on the interface to calculate service area catchments for a facility layer. 5. A form appears in which the user has the option to: 6. Pick a facility layer which may be one of three types: • Public Hospitals (default) • GP Clinics • Chronic Disease Centres 7. Pick a transport mode: • Pedestrian • Private Car (default) 8. Enter in travel time, (5,10, or 20 minutes) 9. Click on a button to show the service area. The system processes the request and updates the map to show travel time from the selected facility in the map view as polygons. 10. The user can visualise gaps between polygons which highlight areas not serviced. 11. The user sends the map to the printer.
Optional Workflow	The user turns on a layer of population statistics to compare demographic data to the accessibility to facilities.
Suggested GIS Data	• Street map/aerial imagery • SLA • Suburbs • Public hospitals • GP Clinics • Chronic diseases centres • Population statistics (optional)

Appendix 4. User satisfaction survey

Please tick the rating you feel most represents your evaluation of the HDSS feature – both performance and importance responses need to be given for each item.		**Importance** **Please provide your rating of the importance you attach to each feature, on a scale of 1-7 where 1 is low importance and 7 is high importance**							**Performance** **Please provide your rating of the performance of the HDSS on each feature, on a scale of 1-7 where 1 is poor performance and 7 is excellent performance.**						
		Low			**Medium**			**High**	**Poor**			**Medium**			**Excellent**
1.	Availability and timeliness of information provided by the HDSS	1	2	3	4	5	6	7	1	2	3	4	5	6	7
2.	Ability to access the system without support from the system administrator	1	2	3	4	5	6	7	1	2	3	4	5	6	7
3.	Accuracy and completeness of the information provided by the system	1	2	3	4	5	6	7	1	2	3	4	5	6	7
4.	Flexibility of the data and its applicability to a range of scenarios	1	2	3	4	5	6	7	1	2	3	4	5	6	7
5.	User confidence in the system	1	2	3	4	5	6	7	1	2	3	4	5	6	7
6.	Ease of access for users to the HDSS	1	2	3	4	5	6	7	1	2	3	4	5	6	7
7.	Current and up-to-date information provided by the system	1	2	3	4	5	6	7	1	2	3	4	5	6	7
8.	Efficiency of the system in setting up, update and maintenance	1	2	3	4	5	6	7	1	2	3	4	5	6	7
9.	Relevance of the system outputs to LBHC	1	2	3	4	5	6	7	1	2	3	4	5	6	7
10.	System priorities that reflect the overall LBHC objectives	1	2	3	4	5	6	7	1	2	3	4	5	6	7
11.	Defining and monitoring information systems policies for the HDSS	1	2	3	4	5	6	7	1	2	3	4	5	6	7
12.	Level of LBHC involvement in defining and monitoring the system	1	2	3	4	5	6	7	1	2	3	4	5	6	7
13.	Existence of a planning agenda to develop the system	1	2	3	4	5	6	7	1	2	3	4	5	6	7
14.	Improvements to the system	1	2	3	4	5	6	7	1	2	3	4	5	6	7
15.	System responsiveness to changing user needs	1	2	3	4	5	6	7	1	2	3	4	5	6	7
16.	Quality and competence of the system	1	2	3	4	5	6	7	1	2	3	4	5	6	7
17.	Technical competence level of the system administrator	1	2	3	4	5	6	7	1	2	3	4	5	6	7
18.	Communication between users and the system administrator	1	2	3	4	5	6	7	1	2	3	4	5	6	7
19.	Data analysis capabilities of the system to support the decision-making process	1	2	3	4	5	6	7	1	2	3	4	5	6	7
20.	Availability of tools in the system to analyse issues related to the Logan-Beaudesert area	1	2	3	4	5	6	7	1	2	3	4	5	6	7

21.	User’s feeling of participation in the HDSS	1	2	3	4	5	6	7		1	2	3	4	5	6	7
22.	User influence on the development of the system	1	2	3	4	5	6	7		1	2	3	4	5	6	7
23.	Helpfulness of the system administrator	1	2	3	4	5	6	7		1	2	3	4	5	6	7

Please tick the rating you feel most represent your evaluation of the following question		**Satisfaction**						
		Poor			**Medium**			**High**
24.	Overall, how would you rate your satisfaction with the HDSS system?	1	2	3	4	5	6	7