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Healthcare Supply Chain Management: Application in the Maltese Healthcare System

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Abstract:	<p>Introduction: Hospital supply chains are complex systems ensuring flow of products/services to satisfy patients. The aim of this exploratory study is to improve the Maltese health care system's efficiency using supply chain management principles in three hospital settings. The theoretical basis underlying the study is the supply chain decision-making framework.</p> <p>Methods: Using observation and focus groups, the following steps were undertaken: (i) mapping healthcare supply chain (HSC) processes, identifying challenges; (ii) understanding competitive strategy through implied demand uncertainty (IDU); (iii) deriving supply chain strategies through supply chain drivers (iv) optimising HSC (right balance between cost and responsiveness); and (v) identifying critical success factors for HSCs .</p> <p>Results: In line with their competitive and supply chain strategies, the three settings have well-defined primary goals, stakeholders' needs/demands/expectations, as well as clear-cut, albeit some similar, criteria and sub-criteria for improving the quality and quantity of their services. The trade-offs between efficiency and responsiveness for the supply chain drivers are distinctive and in line with their competitive strategies, hence achieving the desired fit with the HSC strategies.</p> <p>Conclusions: By adopting HSC principles, there should be improved services in each setting, which in turn should lead to system-wide results.</p> <p>Key words: healthcare supply chain, competitive strategy, supply chain strategy.</p>

Abstract

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Introduction

The global healthcare industry is amongst the world's largest and fastest growing industries.¹ It comprises various sectors, namely healthcare services, pharmaceuticals, medical equipment and supplies, biotechnology and alternative medical sectors.² The delivery of high quality healthcare services, whilst reducing costs, is increasingly becoming a top strategic priority, as healthcare providers are consistently being faced with intense pricing pressures.³ While healthcare providers' energies have been justly spent on identifying and eliminating waste in clinical operations, an effective and imperative approach to further shrink healthcare costs, is to adopt healthcare supply chain principles.⁴

The Council of Supply Chain Management Professionals (2013) defines Supply Chain Management (SCM) as: the management and all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers and customers.⁵ SCM aims to strategically align products and services to segments of customers. Indeed, the seven principles of SCM as developed by Anderson, Britt and Favre⁶ are to segment customers based on their service requirements; to customize logistics network to serve different segments of customers; to align demand planning across supply chain; to differentiate products and services closer to customers; to outsource strategically; to develop information technology that supports multi-level decision-making; and to adopt both service and financial metrics.

While the adoption of SCM practices has been successful in many sectors, the healthcare industry has not seen major improvements from these practices.^{7,8} Nevertheless, knowledge transfer from other industries benefits healthcare, albeit the distinctive elements of the healthcare supply chain (HSC) that makes transference particularly challenging.^{9,10} The HSC, which is dynamic, complex and characterized by uncertainty, is often depicted as disjointed and wasteful.^{8,11} This may be due to the fact that each stage of the conventional healthcare supply chain operates autonomously, thereby precluding it from functioning as a system. Effective coordination between and integration of all supply chain stakeholders will improve supply chain performance.¹² The misaligned incentives and conflicting goals of the various stages and units have obstructed the healthcare industry from successfully embracing and accomplishing system-wide SCM practices. The key goal of the prevailing healthcare supply chain is therefore, to fulfill the needs of stakeholders by the timely delivery of optimal quality products in the right quantities and state-of-the-art services. Stakeholders in the health care supply chain can be divided into eight major groups: producers/suppliers of medical and surgical supplies, medical devices, and pharmaceuticals; purchasers (wholesalers, distributors, group purchasing organizations); providers (hospitals, integrated delivery networks, physicians, clinics, pharmacies, nursing homes); customers/clients/patients; relatives/carers; governmental institutions; regulatory agencies; and insurance companies.⁴

Of relevance to this study, hospital supply chains are complex systems that require the flow of products and services so as to satisfy patients, as well as the needs of those who serve patients.¹¹ Indeed, patient logistics, clinical pathways, data interchange and integrated supply chains have become necessary to deliver health services efficiently and effectively.⁹ Trust, knowledge exchange, IT integration and supply integration are the key factors that influence hospital supply chain performance.¹³ Therefore, restructuring hospital services, characterized by integrated supply chains, is an example of a decisive strategy to cut back on resource utilization and enhance health care quality.⁹

Against this background, the main aim of this study is to provide recommendations for quality improvement of the Maltese health care system using supply chain management (SCM) principles in three diverse hospital contexts, situated within the private, public and private-public partnership (PPP) sectors. The expected major benefit of adopting these principles, is

the paradigm shift from aiming to achieve unit service performance–improvement to accomplishing system-wide performanceoptimal results.

Theoretical framework

The theoretical basis underlying the study is the supply chain decision-making framework (Figure 1) and how this is applied in hospital units in the public, private and PPP settings.

Figure 1

The first part of the framework deals with ensuring flows of technical and clinical knowledge/information, healthcare products/services and funds between suppliers and customers/clients/patients. Within health systems, it is of utmost necessity to share accurate and reliable knowledge and information in an environment of trust along the HSC.¹³ Both knowledge and information connect the supply chain’s various units, thereby coordinating and synergizing their activities so as to maximize total supply chain performance.¹⁰ For example, well-structured and controlled technical information flows are essential to ensure pharmaceutical companies’ supply chain efficiency. In this context, physicians assimilate technical information, create demand and order information, leading to the construction of products/services flows.¹⁰In hospitals, expert knowledge and information flow along patient pathways.¹⁴ The availability of real time information by means of dedicated and integrated IT platforms enables faster decision-making by healthcare professionals, reduces duplication of work and investigations, and results in better patient outcomes.¹⁵ The second part of the framework deals with achieving alignment and strategic fit between competitive and supply chain strategies.^{16,17}

The competitive strategy enables the health system to specify priorities of patients categorized into segments, to recognize patients’ needs, and to understand the uncertainty that the supply chain faces in satisfying these needs. By realizing the supply chain uncertainty, hospitals in public, private and PPP settings are able to identify level of disruption and delays that supply chain must address. The competitive strategy is therefore a dynamic plan for achieving and maintaining competitive advantage through healthcare product/service differentiation, cost leadership, or focus.¹⁸ Relevant to this study, hospitals in the public, private and PPP settings often have specific competitive strategic orientations. Firstly, they implicitly/explicitly specify the patients’ segments that they intend to satisfy. Secondly, so as to ensure their sustainability, hospitals in various sectors must recognize their strategic focus. Public provider hospitals emphasize operations management and cost control, whereas private hospitals accentuate personalized attention and focused expertise to generate profits, as key to their competitive strategies respectively.^{19–21} The HSC requires synergy between the logistic and cross-functional drivers so as to sustain the preferred competitive strategy.²² In healthcare, there are principally three driversfunctions: namely procurement-supply side; operations-healthcare delivery and patients’ requirements-demand side. These three functions are incorporated within the drivers. Indeed, it is considered rather wasteful to continue propagating functions within departments and therefore for these to operate in silos, but rather more pragmatic to consider synergy between logistical and cross-functional drivers. Furthermore, the competitive strategy relies on the objective study of the needs and expectations of customers/clients/patients accessing the different services across the health system. Issues related to customer needs/demands/expectations in this context include customer satisfaction, waiting time/list, personalized care, doctor of choice, quality of care, complications, out-of-pocket fees or free at point of use etc.^{23,24} For example, patients who wish to be seen by their

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doctor of choice or who do not wish to wait in long queues in public sector may resort to out-of-pocket expenditure in private sector. These attributes along which patients' needs in the various health system settings varies, can be combined in one measure – implied demand uncertainty (IDU), which is the uncertainty that exists due to the portion of demand that the supply chain is required to meet.^{17,25} In the healthcare context, emergency care, in contrast to long-term care, with the former's prompt service level and having to meet rising demands, causes IDU to increase because there is less time for emergency physicians to reach definitive diagnosis and start treatment, and because ER has to handle unusual seasonal variations in demand.²⁶

Given the uncertainties it faces, the HSC indicates how, through its capabilities in terms of cost efficiency, response speed and flexibility, the unit/system will achieve its competitive advantages.¹⁶ It is the type of trade-off between these capabilities that often differentiates public, private and PPP hospital settings, with a full understanding of what their supply chain is designed to do well. These supply chains with their different characteristics are placed on a spectrum in terms of their trade-off between responsiveness and efficiency. In line with the World Health Organization's conceptualization of health system responsiveness, HSC responsiveness includes its ability to respond to fluctuations in demand, meet short lead times in providing care, cope with wide range of services, being highly innovative, meet high service levels, and overcome resource supply uncertainty.²⁷ However, the more responsive the HSC is, the more costly, thereby impacting on its efficiency. Therefore, the supply chains within a health system range from those focused on being responsive at the expense of cost as in emergency care or intensive care settings, to less acute/chronic care settings that are focused on providing good healthcare to the wider population but keeping cost in check.

Hospitals will become inefficient if they do not manage to attain a strategic fit between the competitive and supply chain strategies, or their processes/resources do not provide the supply chain capabilities to satisfy the targeted patient segments. If there is a mismatch between what the particular hospital's supply chain does predominantly well and the desired customers'/patients' needs, the hospital would need to redesign the supply chain to align with the competitive strategy or completely change the strategy.

The hospital strategy should be considered at the strategic, tactical and operation levels of management.²⁸ The expected personalized, safe and high quality care delivery renders the healthcare sector into a critical service industry and evolving research setting with a recognition for collaboration between various decentralized supply chain stakeholders.²⁹ In addition, the rising health expenditure as % of GDP worldwide, and globalization of the sector, attracts interest by scholars in SCM. The promising, albeit currently fragmented, research in HSCM, calls for a deeper grasp of the subject area so as to achieve well-performing and sustainable health systems.^{30,31}

Methods

This study was conducted in the Maltese health care system [details on the Maltese health system cf.]³² in the following three contexts: Private Hospital: Surgical/Oncology Ward, which caters for patients undergoing surgery or receiving chemotherapy; Public Hospital: Neonatal Paediatric Intensive Care Unit (NPICU), which is the only NPICU in Malta that serves neonates and children (<3years) transferred from central delivery suite, obstetric wards, A&E, and operating theatres; and PPP: Rehabilitation Hospital, which is the sole entity in Malta that provides physical rehabilitation to patients using a multi-disciplinary approach.

The steps in methodology, using the methods of literature review, observation, and focus groups ([questions asked during focus groups as supplementary information](#)) are the following:

1. Mapping healthcare supply chain processes and identifying issues and challenges.
2. Understanding competitive strategy through IDU.

- 3. Deriving supply chain strategies through supply chain drivers: facilities, transportation, inventory, information, sourcing and pricing.
- 4. Optimising healthcare supply chain (right balance between cost and responsiveness).
- 5. Identifying critical success factors for improving performance of HSC.

Ethical considerations

Ethical permission to carry out this study was granted by the University of Malta Research Ethics Committee. Permissions were sought from the three hospitals. Participants were also given covering letters and consent forms prior to their participation in focus groups.

Results

Emerging from observations and focus groups, Figures 2, 3 and 4 illustrate the process maps detailing the distinct paths, which patients take for their clinical management, whereas the fishbone diagrams highlight the major criteria and sub-criteria that influence the services delivered in the three diverse settings.

Figure 2

Figure 3

Figure 4

The focus groups were then tasked to positioning their settings on the IDU levels versus customer need. As illustrated in Figure 5, NPICU has the highest IDU and needs to be decidedly responsive, in contrast with the rehabilitation setting, whereby promptness is not as urgently needed but costs need to be kept in check. The private ward was positioned in between. This stage shows that services across the Maltese health system have different competitive strategies as shown by the variety in levels of IDU, thereby enabling segmentation of customers. The three settings were then mapped on the uncertainty/ responsiveness graph within the zone of strategic fit as illustrated in Figure 5.

Figure 5

The next step was for the focus groups to develop the efficiency versus responsiveness Table for the surgical/oncology ward, NPICU and rehabilitation unit respectively (Table 1). This process consolidated the discussions undertaken by the participants of the three focus groups when drawing up the process maps and fishbone diagrams, as well as when defining the IDUs.

Table 1

The emerging finding is that the three settings have different primary goals when defining their efficiency and responsiveness. In addition, the trade-offs between efficiency and responsiveness for the logistical and cross-functional drivers are distinctive and in line with their competitive strategies, hence achieving the desired fit with the HSC strategies. NPICU emerges as the setting that has to be unquestionably responsive irrespective of the costs involved, thereby rendering it somewhat inefficient when it comes to use and at times waste of resources. The rehabilitation unit on the other hand has to run efficiently as it needs to cater for large numbers of patients [in particular because of the Maltese ageing population] and therefore can trade-off responsiveness. The private ward is somewhat in between NPICU and

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Rehabilitation Unit. The goal here is a balance between efficiency to ensure profits, and responsiveness to ensure better response and hotel service than found in public sector.

The last step for the focus groups was to identify the critical success factors (CSF) for the three settings. The private ward's CSF are patient/customer satisfaction, patient centeredness, timely and efficient provision of services, transparency and accountability, diversity of services, teamwork and coordination, staff competence and cultural competence. NPICU's CSF are continuous professional development courses, exposure abroad by working in different neonatal units, regular staff meetings and shift meetings which may also involve the whole multi-disciplinary team, team-building sessions and social activities, culture of responsibility and accountability, awareness of staff about infection rates of unit [for example MRSA free days], leadership and approachable management, inclusion of other disciplines for example psychologists, and family-friendly measures. The rehabilitation unit's CSF are clear job descriptions, effective leadership, weekly staff meetings, 360-degree feedback, management support, teamwork, multidisciplinary and client-centered approach, integrated information technology, and development of KPIs.

Discussion

The multiple case studies of the three hospital settings highlight their uniqueness in terms of the market of patients they serve, their supply and demand, competitive and supply chain strategies, IDU, process maps, and fishbone diagrams. In line with their competitive and supply chain strategies, the three settings have well-defined primary goals, stakeholders' needs/demands/expectations, as well as clear-cut, albeit some similar, criteria and sub-criteria for improving their ~~performance~~ services. They are positioned differently on the zone of strategic fit. Despite the fact that the studies were carried out separately with the aim of identifying factors that can improve the ~~performance~~ efficiency of the specific unit, the lesson to be learnt is that the units' ~~performance~~ HSCs impact on the system-wide HSC ~~performance~~ of Maltese health care. While the three settings are not in competition with each other, the extent to which they have an efficient supply chain will impact on the efficient functioning of the entire Maltese health system ~~performance~~. It is to the benefit of the entire health system to use supply chain management principles that strategically align products/services to segments of customers.

This study's findings are in line with a previous study on the Maltese public and private health services,³² which concluded that public and private sectors aim for efficiency to achieve their competitive strategies, despite having diverse incentive systems. By giving profitable services to the private sector, thereby diminishing the load on the public sector, would result in a more efficient Maltese health system.³² Indeed, this study showed that the public sector provides healthcare services [e.g. highly intensive care] that the private sector may not be willing to provide in view of the costs involved to run this service at a profit. In line with the literature, this study confirmed that the private sector aims for high quality healthcare, person-centred hotel services, and patient satisfaction to ensure profitability.^{33,34} Of emerging interest is the rehabilitation unit within the public-private partnership set-up, which despite some scepticism, is becoming popular in Europe.³⁴ Indeed, findings from a systematic review on PPPs highlight the gaps in knowledge with regard to their actual impact on health systems' ~~performance~~ from efficiency, effectiveness and accessibility ~~perspectives~~. This study, in actual fact, highlights gaps in the HSC's ~~performance~~ efficiency of the rehabilitation unit. The focus group emphasised the need for improvements in the rehabilitation unit so as to supply the ever-increasing demand of the ageing population.

The current state of HSC as shown in this study and in line with literature is limited in terms of difficulties with developing system-wide integrated information technology, difficulty in predicting demand, and difficulty in predicting the exact demand for medicines. This may

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be due to lack of supply chain education and awareness of the HSC management, as also reported in the literature in particular within hospitals.³⁵ In hospitals, the supply chain strategy aims for optimizing quality of patient care and person centeredness, ensuring product/service availability, maximizing patient care space, reducing material handling time and costs for all medical staff, reducing storage space, and minimizing inventory.⁴ The way forward for HSC management is to improve information and communication technology (ICT) systems along with automated processing of orders and suppliers close to the hospital to enable rapid replenishment.^{4,7,8} Other options include ensuring cooperation using virtual centralization of the supply chain so as to integrate operations from the market's perspective rather than the health system, thereby controlling costs and improving services. In Malta, this can be applied to integrate the various settings across the health system, which can work together to centralize contracting, procurement, distribution, and logistical operations.¹¹

This study is not without limitations. It is explorative in nature in that HSC was solely analyzed from competitive and supply chain strategic-fit perspective. Specifically, three case studies delivering healthcare were analyzed and these constitute only part of the whole healthcare supply chain. Furthermore, these were analyzed at one time point and therefore did not amply take varying scenarios into consideration. Therefore, future studies of HSC should also explore other domains (e.g. procurement, medical device and equipment supply chain), and other strategies (e.g. hybrid lean and agile supply chain strategies, use of strategic stocking points, postponement and cross-docking from logistics perspective, and demand-pull vs supply-push) of healthcare supply chain, as well as and-across several time points. We hope that this paper will stimulate further research in this direction.

Conclusion

In conclusion, this multiple case study showed the potential use of supply chain management principles to improve ~~performance-efficiency~~ across diverse settings in the Maltese health system. Despite the fact that the current HSCs of these settings seemed to be functioning autonomously, the application of the fundamentals of SCM, namely strategic multi-level decision-making, and that of viewing the supply chain as a single entity, would enable the paradigm shift from unit to system-wide ~~performanceefficiency~~. Finally, the three case studies highlight the importance of identifying any demand-supply imbalance or fluctuations that should trigger an adjustment of the supply-chainHSC. This is a dynamic process that should constantly alert management of identifying needed changes and accordingly modifying drivers, so as to consistently keep these aligned with the competitive and supply chain strategic-fit.

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Proof

Table 1:
Efficiency and Responsiveness for Surgical/Oncology Ward

	Drivers	Efficiency	Responsiveness
<i>Private Surgical/Oncology Ward</i>			
Primary Goal		Supply Demand at moderate cost	Promptness in response to demand
Logistical Drivers	Facility	More storage place for equipment	Proximity of facilities is satisfactory
	Inventory	Effective stock taking system	Inventory to deal with demand uncertainty
	Transportation	Lower costs of mode of transportation	Promptness regardless of cost
Cross-functional Drivers	Information	Effective marketing, transparency and thorough information.	Integrated IT-based systems providing prompt supply chain decisions
	Sourcing	Outsourcing of services to third parties based on price and quality	Sourcing of staff and of supplies/products based upon on flexibility, promptness and reliability.
	Pricing	Price adjustment mechanisms	Price adjustment mechanisms on demand
<i>NPICU in Public Sector</i>			
Primary Goal		Supply demand immediately and urgently irrespective of cost	Absolute promptness in response to urgent and emergency demand
Logistical Drivers	Facility	One unit available for the whole population	Expansion planned
	Inventory	Supplies available, specialized and monitored. Equipment costly.	NPICU collaborates with UK hospitals especially Great Ormond Street Hospital in London.
	Transportation	Satisfactory transportation.	Promptness in mode of transportation, regardless of cost. Transfer to UK if necessary.
Cross-functional Drivers	Information	Information to parents/guardians. Transparency and thorough information.	Immediately responsive to requests and complaints
	Sourcing	Lack of staff, imbalance between junior and senior staff. Supplies provided irrespective of cost. Some waste following medicine reconstitution from powder form.	Sourcing of staff to ensure adequate levels to deal with demand. Sourcing of supplies/products based on promptness and reliability.
	Pricing	Free at the point of use. Costly to hospital.	Needs to be responsive irrespective of cost
<i>Rehabilitation Unit in PPP</i>			
Primary Goal		Supply Demand at a minimal cost	Waiting lists do exist
Logistical Drivers	Facility	Services in one area with privacy. The need for room to be used for group sessions.	Requires a lot of maintenance work. Occupational therapists on community visits to assess the patient in his/her environment.
	Inventory	Limited availability and selection of material in inventory. Occasionally patients have to wait to be supplied.	Government purchases equipment/materials for patients (e.g. splints) or given to patients on loan to try the equipment before purchasing it (e.g. bathroom equipment)
	Transportation	Small number of vans for large number of patients: have to wait.	Responsive in specific/rare cases
Cross-functional Drivers	Information	Referrals and appointments sent by post: take long time to arrive.	Emails used to book transport and for referrals. IT system for patient information.
	Sourcing	Centralized at DH, depending on availability and tendering process.	At the discretion of the Head of the Rehab department to allocate therapists across unit.
	Pricing	Treatment sessions free of charge: funded by the government. Assessments/treatment sessions to foreigners charged a fee.	Pricing for foreigners established.

Figure 1:
Supply Chain decision-making framework

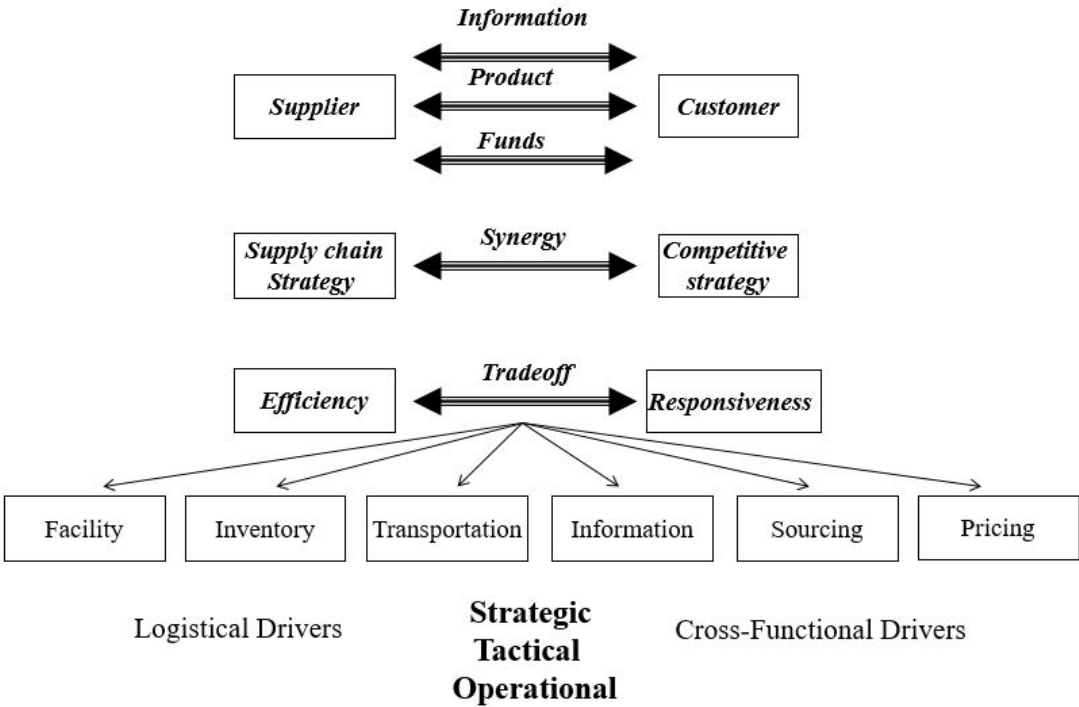


Figure 2:

Process map and fishbone diagram for Private Surgical/Oncology Ward

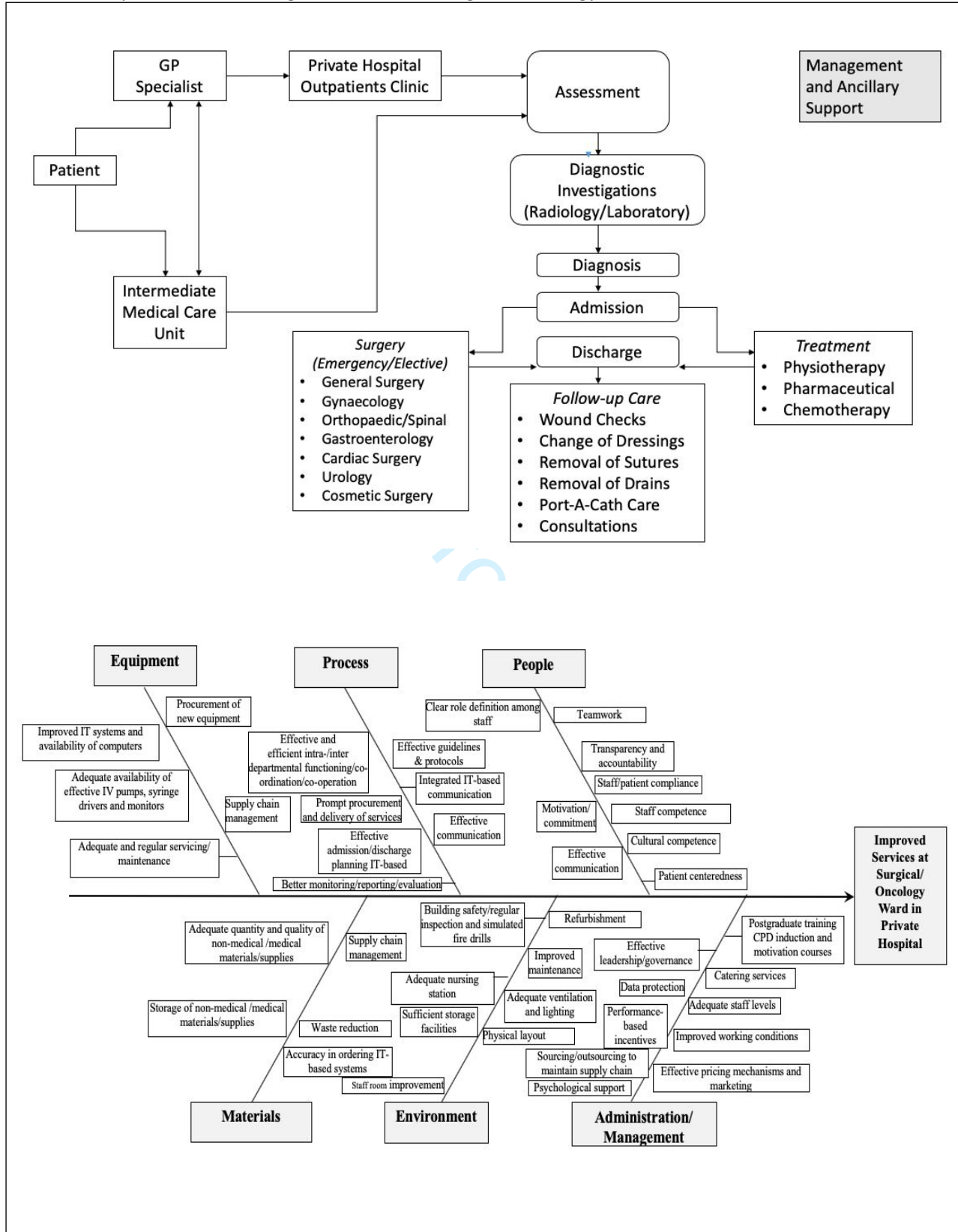


Figure 3:
Process map and fishbone diagram for NPICU

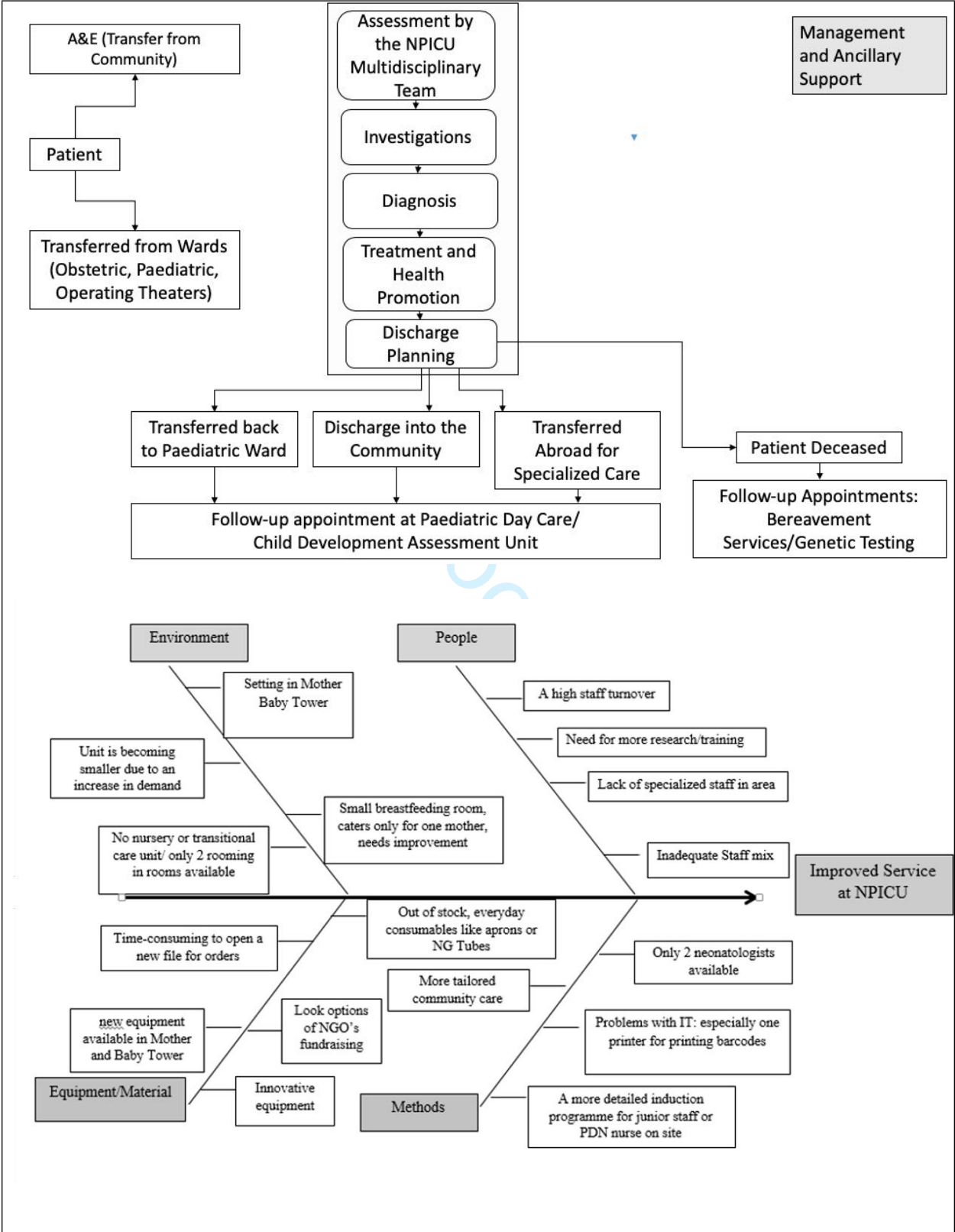


Figure 4:
Process map and fishbone diagram for rehabilitation unit

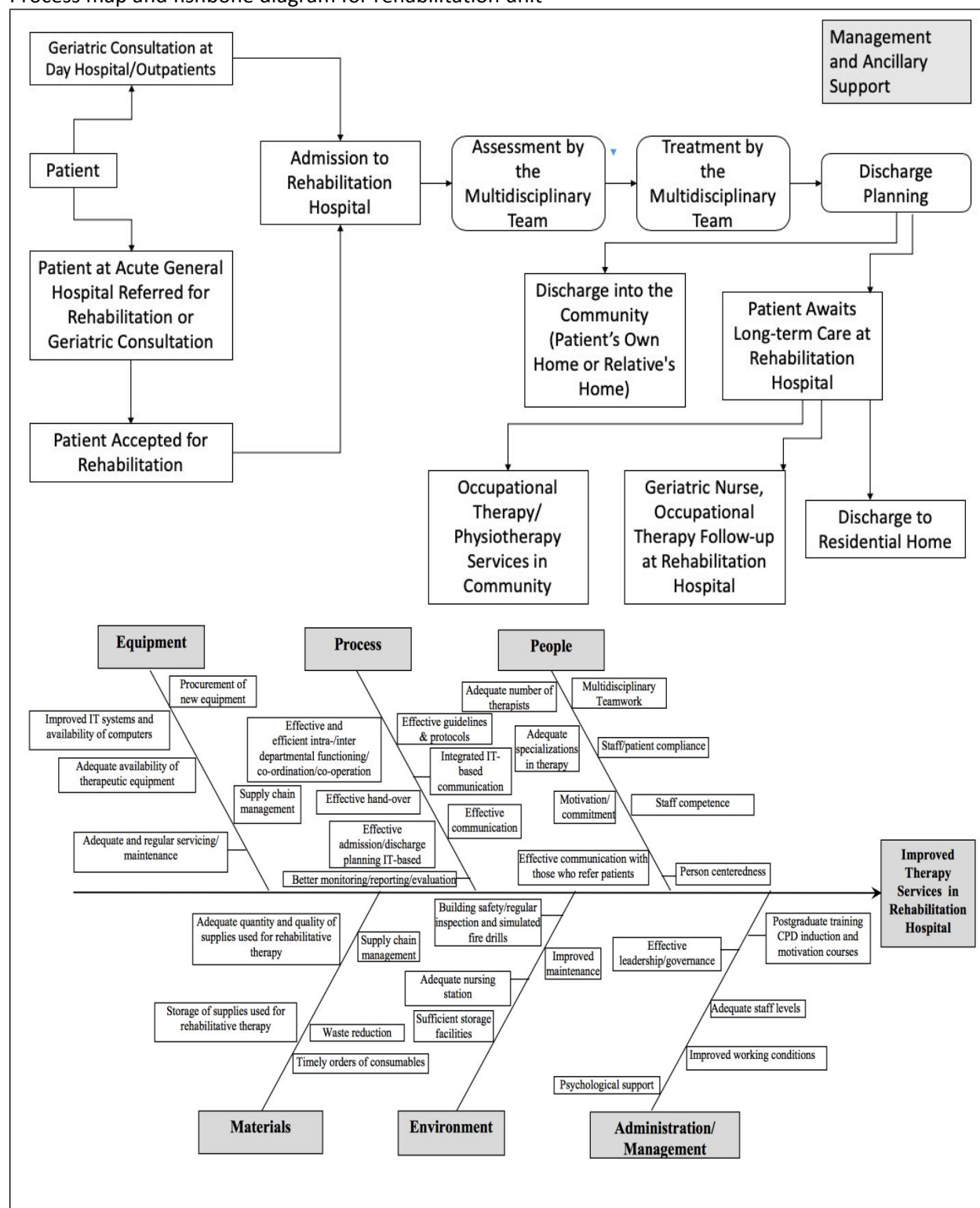
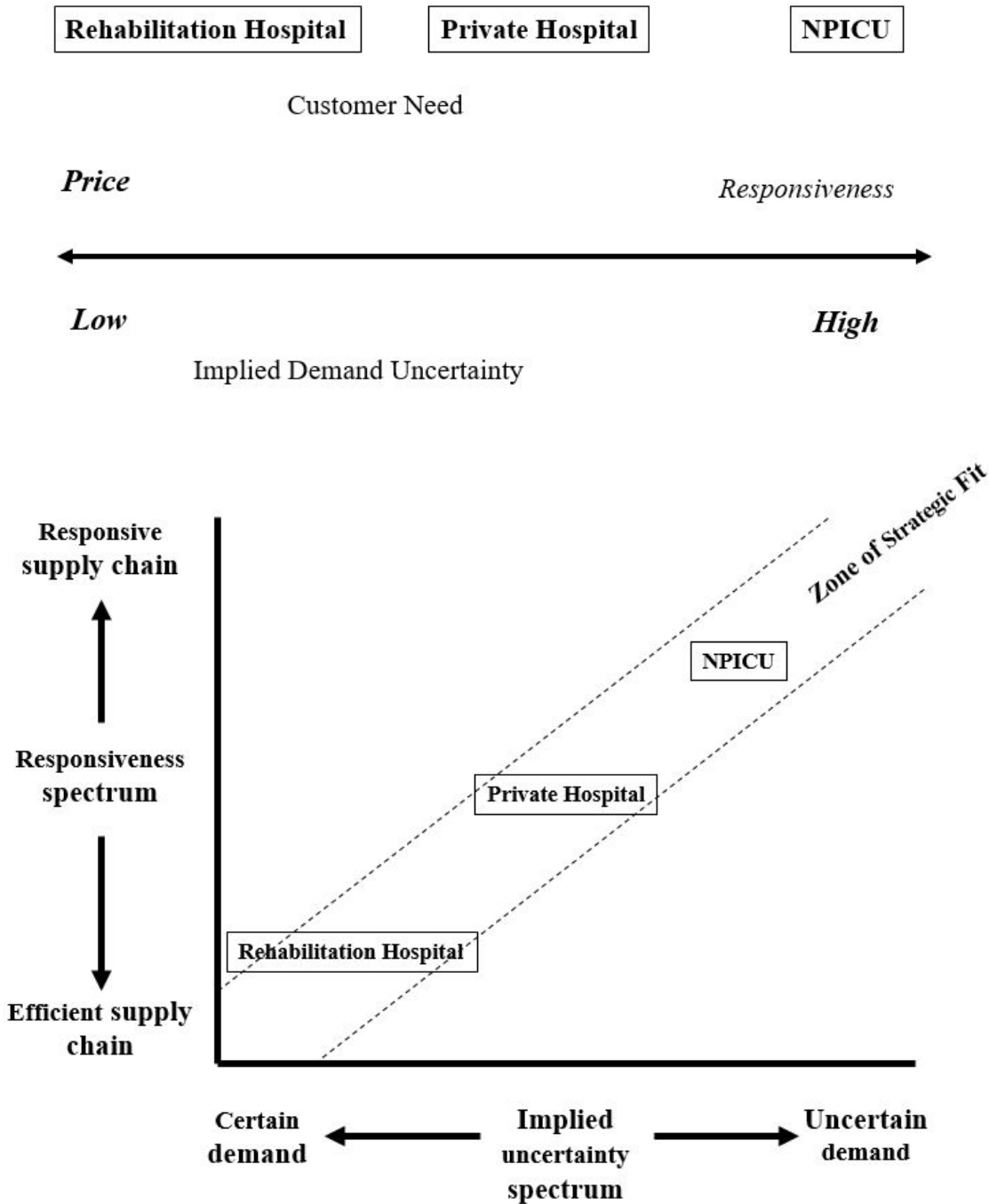


Figure 5:
Levels of implied demand uncertainties and mapping the three units on the uncertainty/responsiveness graph within zone of strategic fit



Schedule of questions asked in focus groups:

A 20 minute introduction was given to the three focus groups outlining the scope of the exercise, defining supply chain (SC) and competitive strategies, explaining supply chain principles and the strategic alignment needed between SC and competitive strategies to aim for efficiency. Each focus group was then guided to go through the following questions:

1. Can you identify and describe the setting that you are choosing?
2. Can you identify and map the supply chain processes - detailing the distinct paths, which patients take for their clinical management?
3. Can you identify sustainable quality issues and challenges in your setting?
4. Can you identify major criteria and sub-criteria that influence the services delivered in the specific case study. (The focus group was asked to draw a fishbone diagram to illustrate their discussions).
5. What are the supply chain's demand, internal operations and supply sides?
6. Are there patients' and Supply chain's uncertainties?
7. Can you identify the needs of the patients' segment being served in the specific case study by the following attributes: demand for service; response time that this segment of patients will tolerate; variety of services needed; service level required; costs of services; and innovation?
8. Can you describe the trade-off between efficiency and responsiveness for the specific case study in terms of primary goal and logistical drivers (facility, inventory and transportation) and cross-functional drivers (information, sourcing and pricing).
9. Against the background discussion and findings so far: can you identify critical success factors that potentially enhance quality and sustainability of healthcare supply chain for the specific case study?