

Integrating Healthcare Processes through Supply Chain Principles

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Abstract

Healthcare supply chain has increasingly attracted the attention of scholars, researchers, government officials, and clinicians as one of the primary strategies in their efforts to reduce healthcare costs while improving quality. Supply chain management is the coordination and collaboration of supply chain participants as a means to achieve system efficiency. The healthcare supply chain is one of these complex systems, with numerous players involved. This study is designed to answer the following questions: How significant is supply chain management to the healthcare sector? Are hospitals in Saudi Arabia properly implementing supply chain principles, techniques, and tools? The theories addressed contribute to a better understanding of supply chain management in hospitals. A case study was conducted at a prestigious private hospital in Jeddah to understand exactly how hospitals in Saudi Arabia are implementing supply chain management.

Keywords

Supply Chain Management, Healthcare, Pharmacy, Supply Chain Map, Inventory Management.

1. Introduction

Human life expectancy in the United States increased from 68.2 years in 1950 to 78.7 years in 2011. (OECD 2013). Life expectancy in the United States is estimated to reach 88.5 years by 2050. (Milken Institute 2013). As people live longer lives, the share of elderly populations will increase, as will the demand for healthcare services. A growing demand for more frequent and higher-quality healthcare services threatens to overwhelm the current healthcare system unless severe efforts are made to improve its efficiency and efficacy. A supply chain is generally defined as an integrated system that synchronizes a series of interconnected processes to: (1) create demand for products; (2) acquire raw materials and parts; (3) transform these raw materials and parts into finished products; (4) add value to these products; (5) distribute and promote these products to either retailers or end-customers; and (6) facilitate these products (Min and Zhou 2002).

To capture the synergy of tetrafunctional and interorganizational integration and harmonization across healthcare operations, we must recognize the strategic importance of planning, managing, and designing the entire healthcare supply chain. The healthcare sector depends on a stable and reliable supply chain. It ensures that the vital industry's health remains in good shape by ensuring that medical equipment, medical supplies, and medication reach the retailer or patient smoothly and in a timely manner. The need of research and collaboration within this sector is crucial to drive healthcare organizations to seek designs that optimize service delivery performance. According to a new global healthcare supply chain industry analysis, the global healthcare supply chain management market will develop at a compound annual growth rate (CAGR) of 7.8% from 2020 to 2025, rising from 2.2 billion to 3.3 billion during the forecast period (Redbird Logistics Services 2020).

The following are the primary drivers of market growth:

- Increased adoption of supply chain management software

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- Emergence of cloud-based solutions
- Reduction in operating costs

The goal of this research is to analyze several literature sources and additional material to present a current summary of research on the several applications of supply chain management in healthcare, while also referencing strategic value drivers in such technique from various views and reports. We have relatively few options for dealing with the current and future healthcare crises, given persistent shortages of healthcare professionals, rising healthcare operating costs, and complex government mandates and regulations. The paper starts with the examination of several approaches that have been used to healthcare organizations in the previous decades to decrease the gap between healthcare operations and other industries as outlined by Ronen et al. (2006). Both qualitative and quantitative methods of research have been used to accumulate information in this report. Aiming to answer my research questions, I have also conducted interviews at a private hospital in Jeddah, Saudi Arabia to find out more about their supply chain practices and implementation. In this paper, information has been accumulated from several journals discussing several uses and areas of improvement in this sector.

2. Literature Review

The literature is examined from three points of view. First, supply chain integration refers to the integration of fundamental activities across organizational boundaries via increased communication, partnerships, alliances, and cooperation. Second, strategy and planning investigate supply chain management as a strategic issue for trading partners, as well as factors related to the amount of planning required. Third, implementation challenges address important criteria for successful implementation, as well as issues particular to inter and intraorganizational components of supply chain initiatives.

Supply chain management is defined as “the integration of key business processes from end-users through original suppliers that provide products, services, and information and add value for customers and other stakeholders” (Cooper et al. 1997). A healthcare system's monetary value can be increased through increasing revenue, healthcare coverage, and healthcare worker productivity while decreasing expenses, service failures, and duplication. Cost management in the supply chain framework necessitates a broad emphasis that is external to the health-care organization. Thus, rather than being a function of output volume, cost can be understood as a result of strategic choices of the healthcare organization's competitive position (Shank and Govindarajan 1993). In other words, a standard cost classification (fixed versus variable cost) that works at the level of a single firm may not make sense for a supply chain network that is affected by many cost drivers (e.g., scope and scale). Activity-based costing (ABC) and the cost of healthcare quality are two alternative cost management principles for a supply chain framework.

Managing the supply chain is more complicated than simply ensuring that providers have adequate gloves. In a 2015 interview, James Spann, Practice Leader of Supply Chain & Logistics at Simpler Healthcare, stated, "Simply stated, supply chain is the management of upstream and downstream relationships with suppliers and customers to deliver superior customer value at less cost to the supply chain as a whole."

The supply chain for pharmaceutical products is crucial in the healthcare business for guaranteeing a high standard of care for patients and appropriate medicine supplies for pharmacies. In terms of cost, it is estimated that supply contributes for 25-30% of hospital operating expenses (Roark 2005). As a result, it's critical that this be well-managed to guarantee that both service and cost targets are reached. The following are some of the challenges that arise at the distribution level, notably from the wholesaler to the hospital:

Product life cycle: Once the active ingredient is patented, the product may take up to eight years to develop into a marketable product (Papageorgiou 2001). Alternative items may enter the market when the patent expires, or corporations may cut the product price (Lauer 2004). New technology is reducing product life cycles, putting further strain on distribution routes.

Profit margins: Despite the high value per unit of pharmaceutical items, operating margins are low, notably in the wholesaling sector. One reason for this is the price control exercised by hospitals, retailers, and manufacturers (Lauer 2004).

Forecasting: Predicting the exact need for medicines is tricky. One of the challenges is the lack of good consumption data. However, the lack of standard nomenclature for healthcare products, combined with professional preferences, adds to the uncertainty (Lauer 2004).

Lack of supply chain education: There is a lack of understanding of the notion of supply chain management, particularly inside hospitals (Lauer 2004). As a result, managers are ill-equipped to control pharmaceutical supplies. In return, a number of initiatives have been launched in recent years with the goal of lowering supply chain costs and enhancing customer experience.

Six Sigma in Healthcare

Six Sigma is a statistical and data-driven approach that examines and eliminates errors or flaws. It focuses on improving cycle times while lowering manufacturing fault rates to no more than 3.4 per million units or events. Bill Smith, an American engineer who worked at Motorola at the time, was the first to introduce it in 1986. As shown in Table 2, it was originally defined as a metric for monitoring defects and improving quality, as well as a methodology for lowering defect levels below 3.4 defects per million opportunities (DPMO) (Pyzdek and Keller 2003). Six Sigma focuses on value-creating or value-adding processes that are critical to customers and bring financial returns to the organization. It is driven by a deep understanding of customer needs and desires, and it seeks to find and eliminate the causes of defects and variability by focusing on value-creating or value-adding processes that are critical to customers and bring financial returns to the organization. Six Sigma's key objectives are as follows (Averboukh 2006):

1. Increase the efficiency of value-added operations in healthcare systems.
2. Maintain process changes, especially through data-driven business process management.
3. Minimize time, effort, and money lost due to errors and failures in specific process steps, as well as non-value-adding activities that follow.

As mentioned in these objectives, the Six Sigma concept complements value analysis in that both aim to remove non-value-adding waste.

Table 1. Sigma quality level and its corresponding yield

Sigma	Corresponding Yield	DPMO
1	30.9%	690,000
2	69.2%	308,000
3	93.3%	66,800
4	99.4%	6,210
5	99.98%	320
6	99.9997%	3.4

As a result, Six Sigma can be incorporated into the framework for value analysis. Six Sigma is divided into five phases (Chowdhury 2001; Harry and Schroeder 2006):

1. **Define** the process improvement objectives that are in line with customer (patient) needs and corporate objectives. This procedure entails establishing the scope of the work as well as the project's leadership.
2. **Measure** existing process after mapping it then, collect important data for comparison and evaluation in the future. This procedure also looks for hints as to what is causing the current issues.
3. **Analyze** using cause-and-effect diagrams to diagnose and validate the link and causation of components. Determine the nature of the relationship and try to ensure that all relevant elements have been examined. This procedure may also include value stream mapping.
4. **Improve** the process using statistical techniques such as design of experiments, and then validate the efficacy and efficiency of the newly modified process. This procedure frequently includes brainstorming.
5. **Control** by using control charts to ensure that any discrepancies are rectified before they cause issues. Set up trial runs to establish process capabilities, then transfer to production and continuously measure and implement control mechanisms.

Six Sigma has successfully addressed a variety of healthcare problems, including (de Koning et al. 2006): shortening the duration of stay in patients with chronic obstructive pulmonary disease; eliminating errors in invoices received from temporary agencies; revising payment terms; allowing parents to room in with their sick children; limiting the number of patients who require intravenous antibiotics; and reducing the preparation time of intravenous medication. Despite Six Sigma's great application potential in healthcare, it is not a solution because it is frequently difficult and only successful at resolving the narrow scope of the present process rather than assisting the healthcare organization in establishing innovative concepts or procedures.

Several publications have been made about the utilization and significance of supply chain management in the healthcare sector. Yet, further research must be done regarding the current advancements in information technology and artificial intelligence, both of which will contribute to effectiveness and productivity of supply chain management in hospitals and healthcare centers.

Healthcare Supply Chain Maps

A supply chain map is a graphical representation of a communication device that assists supply chain policy and decision makers in visualizing key information about distribution channel dynamics, strategic business environments, communication flows, physical product flows, relationships between supply chain partners, and geographical representations of supply chain infrastructure and partners (Gardner and Cooper 2003). This map is useful for getting a clear view of how all supply chain partners are interconnected, where potential sources of supply chain disruptions, vulnerabilities, and dangers are, and who the ideal supply chain partners are.

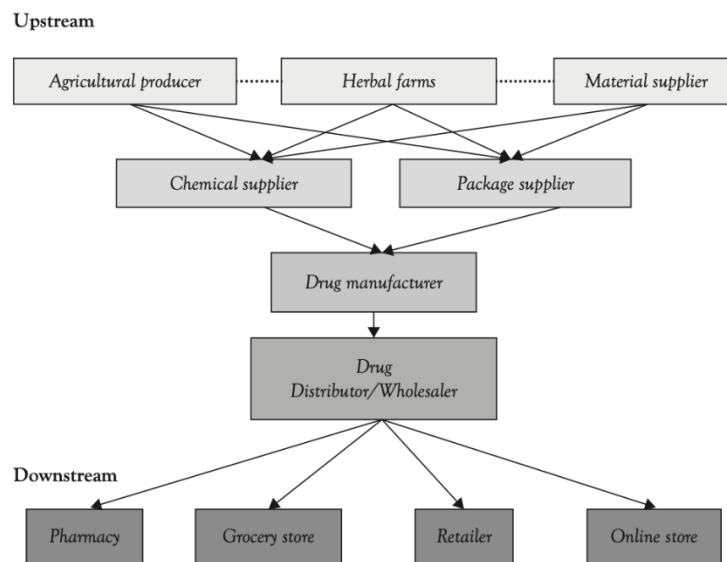


Figure 1. Example of a vertical supply chain map for over-the-counter drugs

A vertical SC map can show a supply chain flow from top to bottom. Typically, the top of the map represents upstream supply chain activity (e.g., sourcing), whereas the bottom represents downstream supply chain activity (e.g., distribution and sales).

A supply chain in healthcare is the sequence of physical and technical resources required to provide a good service to patients with complete satisfaction at a low cost. Manufacturers, Purchasers, Distributors, and Providers are the four groups of stakeholders in the healthcare supply chain based on their functions. Logistics is involved in a variety of operations, including demand/supply management, production control, operation, inventory management, warehouse management, distribution management, and transportation management (Heidari-Fathian and Pasandideh 2017). Logistics oversees two functions: managing resources (wheelchair, stretcher, ambulance), warehouse management

(medical equipment, devices, drugs), and managing workflow (shipping, routing (patient, wheelchair, stretcher, ambulance)).

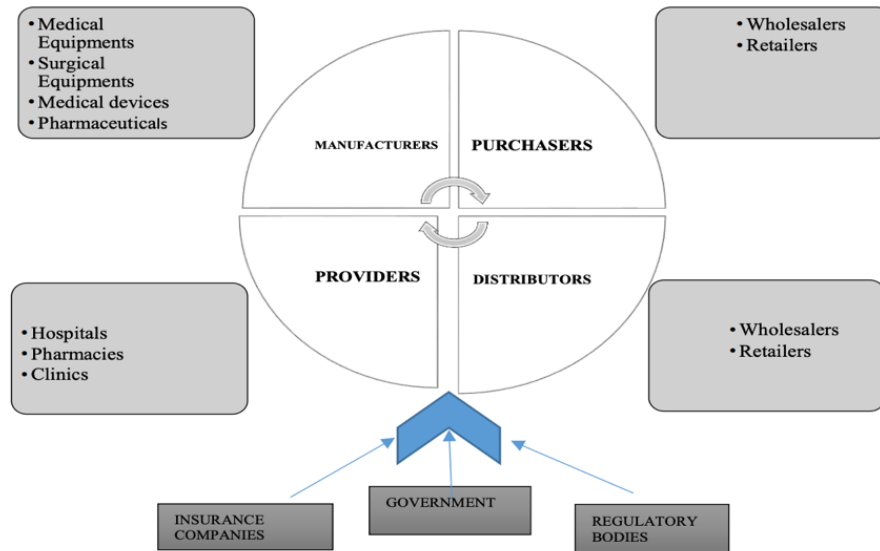


Figure 2. Stakeholders of Healthcare System

In the healthcare sector, the product flow (Figure 3) begins with the manufacturer and ends with the final client at the healthcare provider. Depending on the type of product, it may be delivered directly by the manufacturer to the healthcare provider or may be routed through a distributor before reaching the healthcare provider. The healthcare supply chain is typically characterized as very fragmented and inefficient (Schneller and Smeltzer 2006). The typical healthcare supply chain has a key difficulty in that each stage functions autonomously, resulting in misaligned incentives and conflicting goals that hinder the supply chain from functioning as a whole. These competing objectives, as well as other impediments, have delayed the adoption and application of SCM procedures.

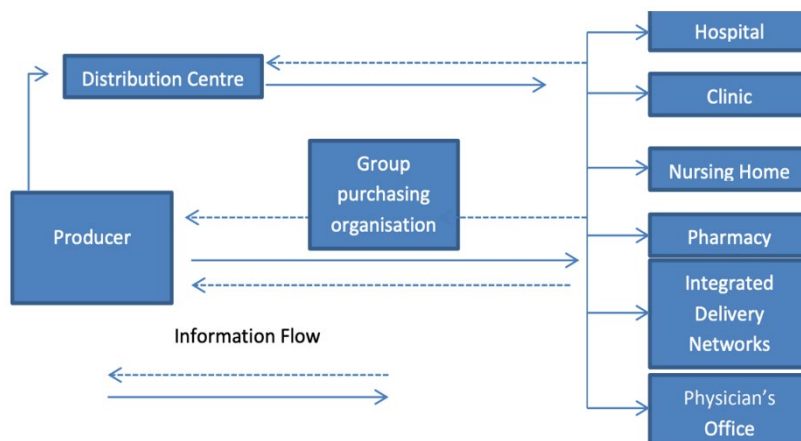


Figure 3. Healthcare Product Flow

3. Case Study

Obtaining resources, managing supplies, and delivering goods and services to patients and providers are all part of healthcare supply chain management. Physical goods and information about medical products and services typically pass through a variety of independent stakeholders, including manufacturers, insurance companies, hospitals, providers, group purchasing groups, and many regulatory authorities, to complete the process.

Through the elimination of wasteful spending, investment, and activities, supply chain principles aim to streamline all healthcare processes related to sourcing needed medical supplies or pharmaceuticals, manufacturing healthcare products or creating healthcare services, marketing (selling) healthcare, and delivering healthcare products and services. The supply chain principle is seen as a revolutionary way of doing business in that it no longer relies heavily on forecasts, it fills the medical order on demand rather than forcing patients to follow the predetermined routine but unnecessary medical procedures. It also enables patients and health-care professionals to make appropriate healthcare decisions based on accurate and timely information across the entire healthcare process.

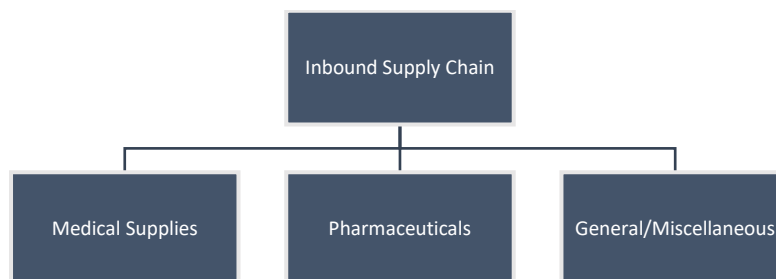
The private hospital in Jeddah, Saudi Arabia, is a multi-disciplinary hospital with specialty centers that offer a wide range of comprehensive treatment options for various health conditions. More than 150 health professionals in more than thirty specialties, including orthopedics, cardiology, oncology, women's health, and children's health, provide these services.

Supply Chain Management at private hospital is coordinated among 3 departments:

1. Warehouse, Logistics, and Distribution
2. Procurement and Purchasing
3. Planning

The purchasing department is responsible for frequent consumable items while procurement is responsible for subcontracting, training, spare parts, and technical requirements. The planning department do the purchase request and procurement do the purchase order. Planning and Warehouse go hand in hand and rely on each other.

The hospital is proud to say that they implement almost all supply chain management tools and their inbound supply chain consists of 3 main categories.



The hospital maintains a stock enough for 3 weeks for every SKU in their hospital building warehouse.

Due to the high-risk nature of a hospital's supply chain, the hospital can ensure availability of all their needed supplies and materials by implementing the following supply chain tools:

1. FIFO (First In, First Out)

The use of the FIFO method is the most appropriate and efficient because it can anticipate expired drugs.

With **FIFO**, the oldest products are used or picked first, ensuring product quality and safety. In other words, the first items stored are the first ones retrieved. FIFO is a commonly used management strategy for perishable stock. This method is effective in reducing waste, increasing storage capacity, maximizing efficiency, and improving organization.

2. ABC Analysis

ABC analysis is a technique used in inventory management to assess the value of inventory items based on their importance. ABC evaluates products based on demand, cost, and risk data.

Class A: Most important products that have the highest monetary value. It is regarded as a smaller category with fewer items but high earnings.

Class B: Products having medium value and medium consumption. Could seasonally fluctuate between class A and class C.

Class C: Products included in Class C are more in numbers but least valuable when it comes to generating revenue.

3. Capacity Planning

Optimizing hospital capacity is not just about patient flow but is equally reliant on staff capacity. Patients, physical space, and staff must be continuously coordinated in order to truly impact efforts to improve hospital capacity planning. The 300 beds available at the hospital are met with adequate staff, spacious rooms, high-end equipment, and sufficient medication all year round. All of which can only be achieved by proper planning.

The hospital has 50 sub-stores in the hospital such as: pharmacy, laboratory, blood bank, emergency room, ICU. Each of these have their own stocks and products stored in their respective department storage rooms. Only 60% of products are common and shared between the main warehouse and pharmacy. The other 40% consist of non-sellable medications, and chargeable items such as: syringes, gloves, and other medical supplies. There are for inpatient usage only and are not sold in the outpatient pharmacy, therefore they do not store them in their storage room. The hospital prioritizes the ICU and Emergency room and always make sure that they have adequate supplies and medication. Inpatient pharmacy requires customization, which is not done by the supply chain department, it is done by the pharmacists.

According to the hospital, some of their most notable uses of supply chain management in include:

I. Pharmacy Supply Chain

The primary goal of the hospital is to offer proper health care to its patients. It is generally necessary to have an appropriate supply of high-quality drugs in pharmacies. Hospital Pharmacy relies on supply chain management to ensure timely availability of medications at the lowest possible purchase cost.

The exact need for pharmaceuticals is difficult to anticipate. As a result, it is critical to collect precise data on pharmaceutical usage in order to establish a trend. In today's hospitals, general storekeepers manage the supply chain, but they are not well aware of supply chain management principles, so it sometimes results in either high demand, low availability, or reverse; as low demand but high availability for some of the medicines, leading to increased shelf life and thus risk of medicine expiry in the pharmacy.

II. Blood Bank Supply Chain

Blood supply management is a major topic in healthcare. The hospital's goal is to manage the blood supply chain dynamically. The supply of donor blood is unpredictable; hence the following points should be considered:

- Blood collection sites should be chosen depending on the commodity required for transfusion services.
- Count of regional blood banks, how supply and demand should be balanced to achieve the goal of on-demand blood transportation.
- In order to achieve the run time requirement, delivery systems must be closely monitored.

III. Patient Safety Supply Chain

According to British Medical Journal (2016), 440,000 patients die each year as a result of preventable medical errors and inadequate safety cultures. The healthcare supply chain is critical to sustaining the vital life and flow of company. A more efficient healthcare supply chain improves care quality and promotes patient safety

Table 2. Minimum Basic Functions

Function	Recommended Best Practices
Pharmacy Information System	Expiry of medicines should be checked on regular basis in case of manual entries. Always ensure adequate supply of medicines.
Blood bank Information System	Set Alarm on Min/Max count of units for each blood type. Blood should be evaluated before using to avoid crisis.
Laboratory Information System	Every sample should be properly barcoded with name and patient ID. Use of disposable syringes, sterilized & single use bottles.
Inventory Control	Critical Equipment's for e.g., Cardiac monitoring system should be in working condition. Proper password authentication before accessing any database.
Billing and collection department	Before bill generation all the department dues should be cleared. In case dues are left it should be added in final patient bill Should sanction the insurance from insurance company.

As mentioned before, Six Sigma is a set of techniques and tools for process improvement. Six Sigma strategies seek to improve manufacturing quality by:

1. Reducing process variation
2. Eliminating errors in processes

When Lean Six Sigma is applied to healthcare, the following outcomes may be attained:

1. Improved patient satisfaction
2. Shorter wait times in emergency rooms
3. Financial recovery due to quality improvement
4. Fewer prescription instruction mistakes

The hospital's inventory has an accuracy percentage of 98% which translates to being in sigma level 3.55. Every day, the hospital is trying to improve their operations and supply chain resilience to improve their sigma level. There is a lot of room for improvement but evidently, all their steps are taken in the right direction and soon enough they will set an example for all hospitals in the region to follow.

3.1 Proposed Improvements

Hospitals do not have control over all the external elements that influence the healthcare supply chain. The COVID-19 pandemic, for example, was a serious supply chain disruption-inducing phenomenon that no one had predicted. The hospital mentioned in the case study, and other healthcare providers can improve their supply chain management to be better prepared for the next major disruption.

They can begin by doing the following:

Making use of demand forecasting technology.

With the correct event and peak demand forecasting tools, they will be able to plan for supply chain interruptions, as well as manage and recover from them more effectively.

Automate and upgrade existing systems.

Making the switch from manual to automated procedures is critical for more accurate and efficient data tracking and analysis. In the event of a disruption, hospitals will be able to respond to shortages sooner and make better use of limited resources.

Engage other departments in supply chain changes.

Supply chain managers must perform their purpose while minimizing expenses for the hospital along the way. As a result, managers may be required to make changes that doctors disapprove of. This issue can be resolved by involving other hospital staff in some of the decision-making processes. The doctors and medical staff will oppose less and be more accepting of the supply chain changes if they feel like they were a part of the decisions being made.

4. Conclusion

Supply Chain Management is critical for healthcare firms because it helps to reduce costs, improve supply chain efficiency, and add agility and resilience to the healthcare value chain. It is essential for patients because it ensures that they have access to the medications and treatments they require. Hospitals in Saudi Arabia have been putting in a lot of effort to build stable and sustainable supply chains, and the hospital in the case study is setting a great example on how to successfully do so. But still, in a climate of rising prices and increased demand for higher-quality service

outcomes, the healthcare industry has been noticeably hesitant to embrace supply chain management approaches. By utilizing supply chain tools such as: Six Sigma, ABC Analysis, FIFO, and Capacity Planning which have been proven to be efficient, hospitals can achieve their goals of achieving all rounded higher quality and better service. The healthcare business is interrelated, one part cannot achieve efficiency while leaving others behind. Healthcare providers are under immense pressure today as a result of increased competition, government regulations, growing costs, and increased demand for improved quality of service. By evaluating supply chain performance, all healthcare organizations can strive for value addition across the whole supply chain.

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