ACTA SCIENTIFIC MEDICAL SCIENCES (ISSN: 2582-0931)

Volume 3 Issue 9 September 2019

Review Article

ARM Analysis Case Study: Digital Indian Health Care System Business Model and Review

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Received: July 26, 2019; **Published:** August 14, 2019

Abstract

Taking into account the importance of the health care industry and the emerging technologies effecting e- health systems, it is crucial to provide the means to review and improve the planning and organization of its systems specially in the early stages of design. The actor relationship matrix (ARM), offers great potential to recognize crucial requirements missing in the system using the stakeholders (actors) interaction with each other to recognize the important business model elements: Actors, Data, Actions, Values and Goals known as the ASOMG. It is also useful to model the elements using the ARM pattern in ArchiMate to further analyze the missing requirements.

Keywords: Health Care; Business; ARM

Introduction

With the wide spread of digital technologies in India, the McKinsey Global Institute recognized the need to prepare a report [3] to shed some light on the potential value for a new ecosystem where the private sector and the government work together to create more value to boost the Indian economy. The report study and thoroughly review four sectors in India to benefit from potential digitization: agriculture, healthcare, retail, and logistics. The project was the result of collaboration between the institute and major sectors such as a Government of India's Ministry of Electronics and Information Technology which led to the report on "India's Trillion Dollar Digital Opportunity" and many other experts in the fields of information technology, telecommunication, agriculture, finance and others.

The report addressed some of the main problems, limitations and circumstances effecting the Indian healthcare environment and as a result the report was able to indicate some goals and suggested a schema for the digital ecosystem. To achieve an adequate digitization, periodically reviewing the system in light of the current advances is important to check the completeness of the requirement and to draw attention to potentially improvement opportunities.

In this research we make an effort to review the Indian health care system report using ARM as a case study. We first analyze the system briefly then use the ARM to assess the completeness of the requirements. We also produce an ArchiMate model of the ARM to assess in the requirements assessment. Finally, we propose some importing system design enhancements and the technologies associated to address some of the related problems in the healthcare system mentioned in the report.

Related work

According to Orlikoff and Totten [20] The term e-health refers to "The use of the Internet and related information systems and technology in all aspects of health care". It is vital to create a business model for the success of the collaboration of e-health services

ARM is a two-dimensional matrix which defines relationships among actors to analyze the requirements from the point of view of

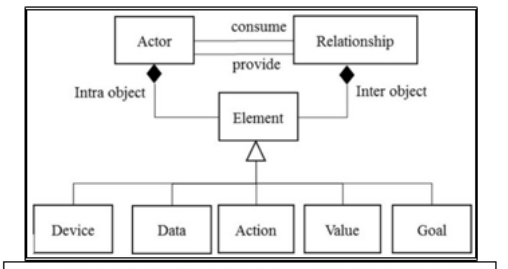
the relationship among them. It was first introduced to check and ensure the completeness of the strategic dependency model (SD) of the well- known goal-oriented requirements analysis known as the i* framework .It was suggested as bases for i* modeling because it was difficult to check the completeness of the SD model in a systematic way with the large number of actors in business cases and the growing complexity of the relationships between them, ARM it was proven to organize requirements and goals among those actors [1,2].

The five key business model elements of the e-health business model referred to as ASOMG were extracted after reviewing several case studies and by extracting elements from existing e-heath case studies consisting of important elements for e-health models' innovation. It was concluded that they could also represent any business model based on the work of Yamamoto., *et al*., In [5]. The elements included: Actors, Data, Actions, Values and Goals.

They were included in the developed meta model for ARM in [4]. The work of Yamamoto [7] on deriving business values for ArchiMate from the actor relationship matrix and the work of Yamamoto., *et al*. [5] on proposing a business modeling method for e-Healthcare based on ASOMG analysis, resulted in creating a meta model for the ARM to analyze e- health business models as shown in figure 1 (top).

A clear analysis of the e-healthcare business models using ARM has been supported by the use of ArchiMate. ArchiMate is a standardized language to model Enterprise Architecture based on TOGAF which is the most popular enterprise architecture framework [6,8], the expressive power of ArchiMate and its rich features enhances the clarity of the architecture business model elements and aids in the analysis of the architecture.

The use of ArchiMate modeling was proposed to describe e-health business model in [5] and was proven to be applicable and proper for the elements of the e-health business model. The elements were later mapped to the elements of the ArchiMate modeling language and a an ArchiMate pattern was created representing ARM. Figure 1 (bottom) shows the mapping of ARM elements to the ArchiMate elements from [4].



ARM elements	ArchiMate elements
Actor	Business Actor
Data	Business Object
Action	Business Service/ Process
Value	Business value
Goal	Business Goal

Figure 1: ARM meta model top and ARM elements and their corresponding ArchiMate elements from [4].

Overview of the ARM and definition

Assumed is the two-dimensional matrix M for actor A_K where K∈{1,...,*n*}as M[A_i, A_j], which represents elements actor A_i expects for actor A_j and M[A_i, A_i] represents expectations of actor A_i from and by itself. Where G_A in a diagonal manner as intra elements means goals of A and E_{AB} as Inter elements in a none-diagonal manner means the expectations of A from B.

	Actor A	Actor B	Actor C
Actor A	G_A	E_{AB}	E_{AC}
Actor B	E_{BA}	G_B	E_{BC}
Actor C	E_{CA}	E_{CB}	G_C

Table 1: Actor relationship matrix.

General review of the Indian digital health care system

In order to keep up with the growth of digital technologies and to take advantage of the rapid adoption of technology in India to support a new digital ecosystem, the McKinsey Global Institute prepared a report [3] focusing on the potential of digitization and the collaboration between different private and public sectors to create more value based on supporting economic and management deci-

sion making. The report study and thoroughly review four sectors in India to benefit from potential digitization: agriculture, healthcare, retail, and logistics.

In this research we only focus on their report concerning the Health care sector [16], it discusses the current situation of the healthcare system in India and offers an excellent insight on how to reach a digital transformation based on available services.

The main argument of the health care system section of the report is that India needs an improved health care system to avoid the increasing morbidity and mortality rates. Using a comparative study to other countries experience, the report concluded and categorized the main problems into:

- Access: Shortage of doctors, patients access to general care, high prices of premium insurance, high costs in general.
- Quality: Extremely fragmented outcomes of providers, the outcomes are not measured, poor channels of communication hinder sharing best practice and causes doctors and health practitioners to lose contact and follow-up with patients and finally the lack of specialists.
- Patient experience: Low patient satisfaction due to: lack of access to information such as the unknown doctors' and health practitioners' qualifications and quality of work, absence failure of doctors to see the patient even with an appointment.

The report proposed a solution by recognizing three main tasks using practical digital technologies and innovation: Improve connectivity, automate routine tasks and analyzing patient's data to improve care decisions.

Initial analysis of the report

To understand the economic value of the digital transformation proposed in the repot for healthcare solutions, it is important to regard the role of a clear business model. In this initial analysis of the report, we recognize the five key business model elements referred to as ASOMG. The report presents 3 main exabits to illustrate the sought digital transformation.

The first exhibit shows the schema proposed on how the Indian healthcare system could look using digital application in five to ten years. From the exhibit we can define the main actors in the schema: patients, doctors, clinical staff, distributor, pharma company and Insurance company.

It also shows the means used to achieve the proposed digital transformation which includes applications and technologies including: patients facing digital applications, digital insurance platform, telemedicine platform, telemedicine, electronic health records, chronic disease management, and evidence-based care analytics. Other technology means include: diagnostic devices, management apps (chronic diseases management apps, pharmacy mobile app) and wearable devices.

Another exhibit demonstrates the patients experience in rural remote clinics with the health extension workers, we regard the flow as the "patient actions" or "business process". The following figure shows the result of our initial analysis.

Services	1. Telemedicine 2. Monitoring with IoT peripherals 3. Online doctor comparison 4. Automated Health record system 5. Automated Applications for chronic diseases management 6. Automation of claims and scheduling 7. Accountability tools 8. Evidence-based care analytics 9. Data-driven utilization management and risk sharing 10. Digitized insurance underwriting and claims
Data/Business objects	Patients data (electronic health records, financial records, wellness records)
Business goals	• better connecting people with services • automating routine tasks • analyzing patient data to improve care decisions • patient centric health care with integrated, seamless delivery of personalized health solutions. • Improve the quality of patient experience • Save time • Accelerate diagnosis and treatment • Cost effective • Changes in the digital driven new paradigm should enable care focusing on patients throughout their cycle of treatment, starting with pre-diagnosis. • Such digitally driven changes can save time, accelerate diagnosis and treatment, and make it simpler to manage chronic diseases at every step.

Figure 2: Key business model elements extracted.

Developing ARM for the Indian digital health care system

In this section we review the proposed health care system case by applying the ARM then in later section we evaluate the case based on the results.

In the following table we show a simple ARM for the proposed digital health care system where the main consumer is the patient

and the providers are represented by doctor, clinic staff, distributor, pharma company and insurance company. The elements of the matrix are sometimes represented by a number referring to their relation to services in table 1.

According to the report the goals of patients, doctors and medical staff is specific where goals of the distributor, pharma company and insurance company were not specified clearly. We assumed some of the goals and requirements from the context of the report but we believe that there is still a need to specify some clear goals and requirements (concerns to be addressed) to achieve a sound and precise analysis and transformation plan. Further evaluation of the case is presented in later section.

	Patient	**Doctor**	**Clinic staff**	**Distributor**	**Pharma company**	**Insurance company**
Patient	**Patient's goals:** Increase Healthcare integrity. Reduce cost. Convenience Privacy.	Accurate diagnosis Accurate course of treatment and Availability.	Helping in checking in. Leading to telecon-sulta tion room. Extracting records and recording vital signs and symptoms in an electronic health record (EHR)	Not specific	Not specific but generally Medication	Not specific but general-ly Insurance
Doctor	Not specific But generally Experience and cooperation	**Doctor's goals:** Aid in diagnosis and treatment (1,8) Accuracy (4,5,2) Convenience in communication and in sending and receiving data and health records (1,4)	Extracted medical records. Recorded vital signs. initiating the video call	Not specific	Not specific but generally Medication	Not specific but general-ly insurance
Clinic staff	Required information for checking in the patient Recorded vital signs and symptoms	Prescribed medication to be supplied to the patient directly from the clinic. Info about the next appointment to be followed. Full info of diagnosis and medication to be recorded on the (HER)	Clinic Staff Goals: reduce work load (4,5,6,7)	Not specific	Not specific but generally Medication	Not specific but general-ly insurance
Distribu-tor	Not specific	Not specific	Not specific	Not specific but gener-ally automation	Not specific	Not specific
Pharma company	Not specific	Not specific	Not specific	Not specific	Not specific but generally Increase in sales automation	Not specific
Insurance company	Not specific	Not specific	Not specific	Not specific	Not specific	Not specific but gener-ally Increase in sales and automation

Table 2: ARM for the Indian digital health care system.

The previous table elements can be represented as follows in figure 3

Patient:
Intra elements ARM [Patient, Patient] are increase healthcare integrity, reduce cost, convenience, privacy. **Inter elements ARM [Patient, Doctor]** are accurate diagnosis, accurate course of treatment and availability. **Inter elements ARM [Patient, Clinic Staff]** are helping in checking in, leading to teleconsultation room, extracting records and recording vital signs and symptoms in an electronic health record (EHR) **Inter elements ARM [Patient, Distributer]** is not specific **Inter elements ARM [Patient, Pharma Company]** is not specific but generally Medication **Inter elements ARM [Patient, Insurance Company]** is not specific but generally Insurance
Doctor:
Inter elements ARM [Doctor, Patient] is not specific but generally Experience and cooperation. **Intra elements ARM [Doctor, Doctor]** are aid in diagnosis and treatment (1,8), accuracy (4,5,2), convenience in communication and in sending and receiving data and health records (1,4) **Inter elements ARM [Doctor, Clinic Staff]** are extracted medical records, recorded vital signs, initiating the video call **Inter elements ARM [Doctor, Distributer]** is not specific **Inter elements ARM [Doctor, Pharma Company]** is not specific but generally Medication **Inter elements ARM [Doctor, Insurance Company]** is not specific but generally insurance
Clinic staff:
Inter elements ARM [Clinic Staff, Patient] are required information for checking in the patient, recorded vital signs and symptoms **Inter elements ARM [Clinic Staff, Doctor]** are prescribed medication to be supplied to the patient directly from the clinic, info about the next appointment to be followed and full info of diagnosis and medication to be recorded on the (HER) **Intra elements ARM [Clinic Staff, Clinic Staff]** are reduce work load (4,5,6,7) **Inter elements ARM [Clinic Staff, Distributer]** is not specific **Inter elements ARM [Clinic Staff, Pharma Company]** is not specific but generally Medication **Inter elements ARM [Clinic Staff, Insurance Company]** is not specific but generally insurance

Figure 3: ARM elements of the Indian digital health care system.

ArchiMate model based on ARM elements

Based on the ArchiMate pattern of e-Health service [4] and using the ARM elements and the initial analysis of the digital healthcare case, the following ArchiMate models were produced to further review the services in the report. The model was divided to two parts; first part shows the Digital health care system process and its relation to the healthcare staff, doctors and patients and the second part shows services provided by and used by actors. Note the assignment and association relation arrows. Even though "executives" and their roles weren't regraded as actors in the report we deliberately and accordingly added "executive" as an actor in figure 5 for reasons argued in section 7.

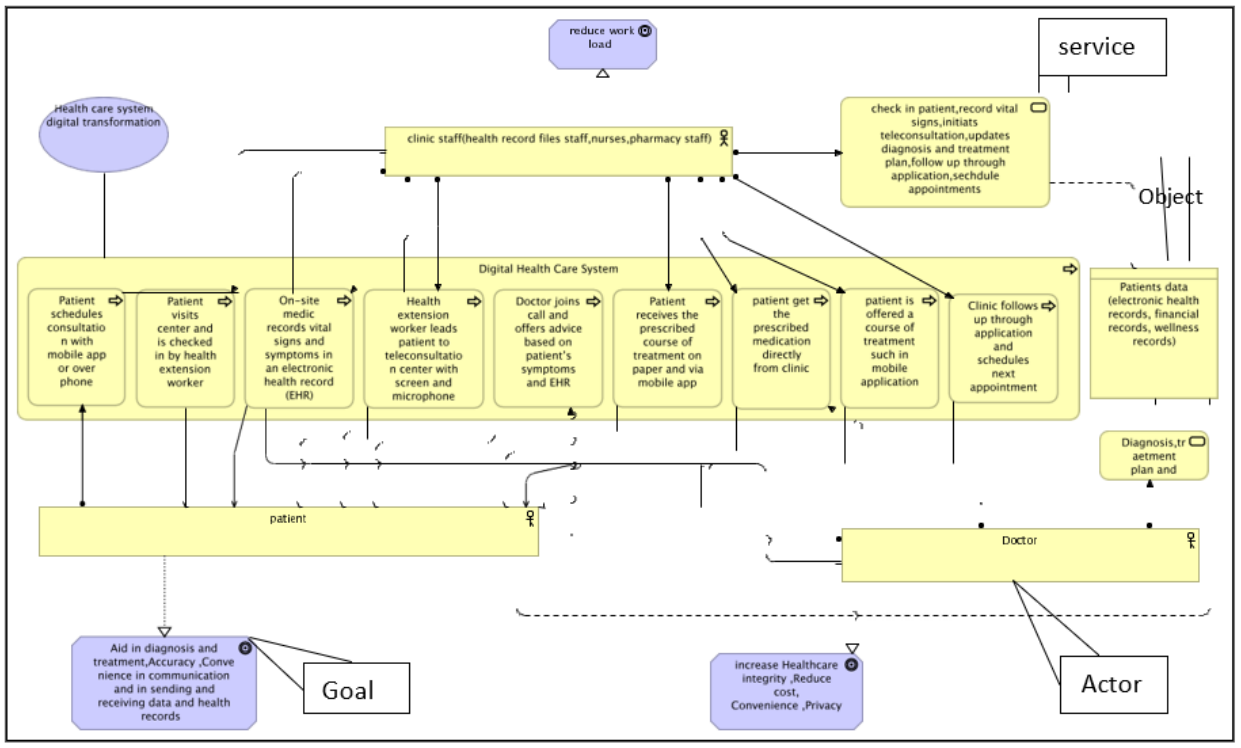


Figure 4: ArchiMate model for the Digital health care system process and its relation to actors.

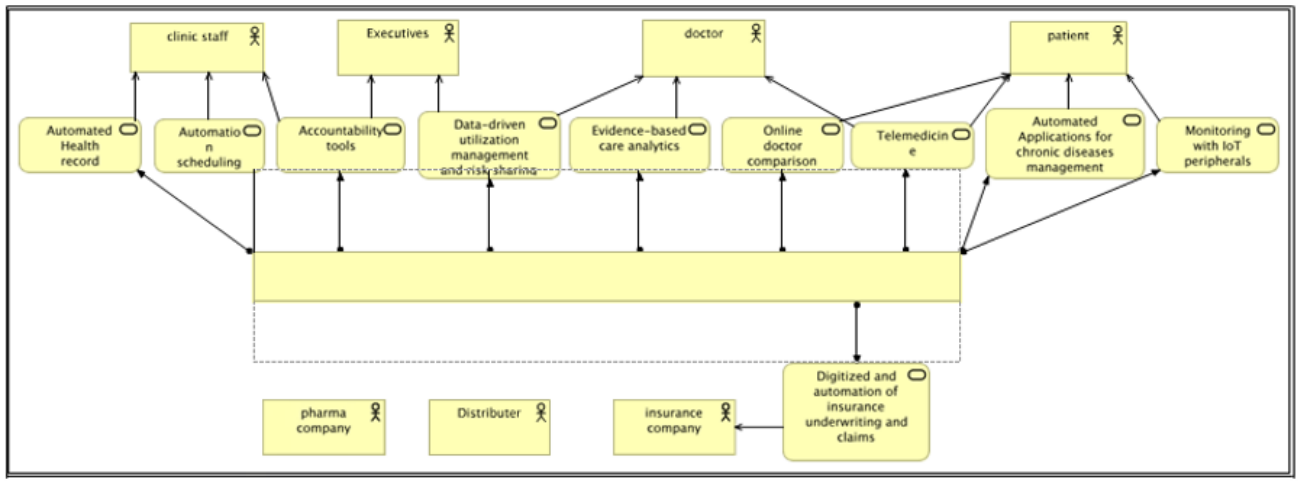


Figure 5: ArchiMate model for services provided by and used by actors.

General evaluation of the Indian digital health care system completeness based on ARM

ARM was proven to be useful in detecting missing requirements. In this section, we assess the completeness of the case study [16] using ARM table approach and the derived ArchiMate models. Then we propose some notes to support completeness of the requirements and goals based on the ARM analysis. We don't assume knowledge about the Digitization of Indian digital health care system and we take the case merely as presented and described in the report. After presenting the ARM approach based on the landscape schema shown in the report in [16], we noticed the omission or the short mentioning of possibly vital actors, their roles, services and their motives. The omissions are divided into:

- Missing actors in the landscape schema and their importance based on the report itself (section6.1)
- Omissions in existing actors in the schema and in the report (section 6.2)

Missing actors in the landscape schema and their importance according on the report itself

The case study addresses and mentions patients as a consumer and doctors, clinical staff, distributor, pharma company, Insurance company as providers but doesn't address executives, service provider, diagnostic labs, specialist, hospitals or health care facility as super entity and pharmacies clearly. Based on the report, we argue that other vital actors should also be considered in their initial landscape schema including: health care facility as super entity, Executives and service provider.

The report mentions the lack of chief executives engaged in digital initiatives (only 40% of chief executives at digital leaders) and how they should seize the benefits of digitization by quickly adapting their companies in the correct manner. In order to do so, executives and legislatives should be clearly mentioned. While the schema and models presented show the digital means to achieve connection, automation and analysis using digital platforms it doesn't regard the role of executives and their vital involvement with distributor, pharma company and insurance companies and most importantly with important influencers for their decisions such as patient feedback. For this reason, a land scape of the proposed digitized healthcare system should be provided.

Looking at the ARM the, health care responses involved with distributor, pharma company and insurance company should be communicated to executives while patient feedback should reach executives directly.There is also a need to address the role of service providers in general. the report talked about different types of service providers such internet and mobile service providers, electronic health record providers and health care providers.

One of the goals of the digital health care system mentioned in the report, is to achieve a new paradigm that will encourage integration between providers to personalize uniform health solutions, these providers aren't mentioned in the schema to clearly recognize dependencies, motives and goals.

Omissions in existing actors in the schema and in the report

The schema clearly shows the pharma company relationship with the distributor, physician, patient data ecosystem, insurance and a patient facing digital application. However, while creating the ArchiMate model from the ARM, we also noticed a missing mechanism for medication dispensing. In reports redefinition of the primary health care model, the medication is dispensed directly from the clinic.

Also, the elements of concern to pharma company is not clear such as their interest and expectation and their specific services towards and from other actors such as doctors, clinical staff and insurance company. Other noticed omissions include the insurance company concerns and expectations and their specific services to and from other vital actors, the report mentions the need to reduce insurance cost but no general analysis has been performed to achieve that goal.

Finally, the distributers goals and their specific services to and from other actors were also omitted from the general analysis.

Suggestions on achieving a digital transformation

The reports effort is to solve the main problems in the Indian health care sector which according to the report, is related to: access, quality and patients experience. The report also suggests the solution is digitizing the system to remove the boundaries between healthcare sector in order to create a more patient centric health care system. The report explored some digital applications related to the tasks of automation, connection and analysis.

In this section we propose some importing system design enhancements and the technologies associated to address some of the related problems in the healthcare system mentioned in the report. We emphasize on the aim of the report to achieve an integrated personalized patient experience. To support and achieve health goals of the Indian healthcare, an e-health architecture is necessary to support the e-health services. The results from the survey presented in [9] shows the importance of eHealth strategies, organizational change, appropriate technological infrastructure and shows that there is a shift towards development of the entire health system based on them.

Health care information systems could be classified as enterprise information systems because of their size and complexity and therefore the design of frameworks and enterprise architecture can be used to reduce complexity and increase adaptability and resilience of the information systems. With the continues change surrounding systems such as social, political and technology changes and advances, there is a need to keep up with the transformations in a consistent manner for a more resilient system [10].

That is why we suggest the use of customized application of enterprise architecture frameworks such as TOGAF ADM. The benefits can be observed in the successful cases of application of TOGAF EA framework in healthcare systems in Australia and Canada [11]. Suitable application of the EA could be the adaptive integrated digital architecture (AIDAF) by Masuda., *et al*. [12], it was proposed and verified in the case study [13] where adaptive EA is aligned with IT strategy supporting mobile cloud, mobile IT and digital IT. There are also several efforts to achieve an efficient IoT digital platforms at the middleware and application layer in the healthcare industry such as in the "Open Healthcare Platform 2030 – OHP2030" (OHP2030) [14]. In the initiative of the open platform for health care related IoT services [A Vision for Open Healthcare Platform 2030], an AIDAF based model is proposed to achieve a secure and efficient layer interoperability. Interoperations is when Several systems are collaborating where one system provides operations to the other to perform services and achieve goals in healthcare systems, the collaboration should also be taken in consideration to achieve the important characteristic of Enterprise interoperability [15].

To address the issues presented in electronic health care systems such as data management and interoperability, cloud computing infrastructure should be discussed to achieve the reports goals of data management and accessibility [17].

To acquire and manage sensor data on the Cloud, there is also a need to address IoT based architecture. Some research could be referred to address efficiency in the cloud environment for a central-

ized architecture for the integration of IoT in healthcare systems such as the use of the FOG computing, "Fog provides the missing link for what data needs to be pushed to the cloud, and what can be analyzed locally, at the edge", explains Mung Chiang in [18] to address security and privacy issues, the Fog computing is proposed in [19] to assure Security and privacy for patients' medical data.

We also propose a high-level design for the health information system to address previous issues. The high-level design of health care infrastructure and ecosystem should be in a wholistic patient centric manner where all the patient's life stages are taken into consideration in a lifelong healthcare system and a clear lifecycle.

Conclusion

In this case study, we reviewed the report on the proposal of digitization of the Indian Health care system. The use of ARM facilitated the assessment of the completeness of the requirements, the elements of the business model ASOMG were extracted for the ARM analysis and an ArchiMate model was constructed. The evaluated report of the Indian health care system was created to inform about the current situation of the health system in India.

The report proposed a brief plan to enhance and create a unified system focusing on the patient and using the current technologies currently in use by the system. Our review showed some missing elements and requirements which could serve the goals of the report and an open opportunity to apply more system design enhancements and the technologies such as Adaptive enterprise architecture frameworks.

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