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Factors Affecting the Adoption of Smart Technologies for Traceability of Raw Materials in the Retail Industry

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Abstract
The effect of contaminated raw materials within food products has great effects on both the organizations who produce them and the customers who consume them. Some businesses have nearly gone bankrupt due to contamination issues, and there have been fatal cases of consumers who digest these contaminated products. The study objective is to explore the factors affecting the adoption of smart technologies for traceability of raw materials in the retail industry. The study used a systematic literature review to explore factors affecting the adoption of smart technologies in the traceability of raw materials in the retail industry. The TOE framework has adopted the lens to understand the factors affecting the adoption of smart technologies. The study results indicate technological, and environmental factors affect the adoption of emerging technologies in the traceability of raw materials in the retail industry The study contributes to the body of knowledge on factors that affect the adoption of emerging technologies for raw material traceability in the retail industry.

Keywords: emergent technologies, retail industry, traceability, technological, organizational, environmental factors

Introduction

The nature of the problem arises from customer complaints about a certain product, which was not up to the expected quality standard. The investigation would then commence finding the root of the problem, which is normally within the raw materials of the product. Following this would include the action of traceability to trace back and identify the cause of the problem. In the field of raw materials, process industries make use of production processes that change material properties to create enhanced raw materials for subsequent use in many different areas in a supply chain (Souali, Rahmaoui, & Ouzzif, 2017). Process firms make use of such raw materials to manufacture or produce incomplete products via production processes, where such materials are then transformed into a continuous flow in batches (Florén et al., 2013).

Akindipe, (2014) state that raw materials play an extremely important role in efficient and effective operation in a manufacturing organization. The availability of such raw materials at the right quality and the right quantity will, to a reasonable extent, determine the availability, quality, and quantity of the final product produced. The correct management of these resources can prove crucial to the overall performance of manufacturing firms. Raw materials influence many businesses orientated events; such include general price index, activity level, and ultimately the profit generated by companies. According to Souali, Rahmaoui, and Ouzzif, (2017) "traceability can be defined as the ability to keep a detailed history of all activities and changes that a particular object can undergo throughout its entire lifecycle, taking into account the different relationships that may appear. This particular object can be a material, a product, a model, or even a class in a software development platform. The objective of the study was to explore factors that affect the adoption of emergent technologies for traceability of raw materials in the retail industry.

Literature Review

The new technology advancements and developments are many reasons for the shift from the third to the fourth industrial revolution (Xu, David & Kim, 2018). They further state that the 4th industrial revolution is taking off from where the 3rd one has left us. The main reason why this new revolution is seen as a distinct revolution of its own is due to the difference in velocity, scope, and impact compared to the 3rd revolution. Xu, David, and Kim (2018) note that the consumers are the ones to benefit most from this revolution; it has the possible effects of rising income levels of entrepreneurs as well as improving the quality of life for general society.

The new revolutionary technologies of the fourth industrial revolution include the fusion of multiple technologies available; making them work together as complementary products. Such technologies would include more advanced 3D printing; the internet of things (IoT); artificial intelligence; autonomous vehicles and many more. With the aid of such technologies working harmoniously together, creating, storing, and distributing information; the 4th industrial revolution would be achieved and (Xu, David & Kim, 2018). They described the Fourth industrial revolution as a combination of these various technologies which blur the lines between physical, digital, and biological spheres. Technologies such as Radio frequency identification (RFID) and barcodes are used for raw material traceability by organizations.

White et al., (2007) highlighted a few issues related to the use of RFID. He stated that there are additional expected costs and issues to be experienced by organizations when implementing RFID in their supply chain management processes. These issues would be consumer privacy concerns, data storing issues, and globally agreed-upon operating systems. Extra costs would include hardware and software installation and maintenance costs as well as training costs for employees. Barcodes on the other hand are rather out-dated in today's technological world, and White et al., (2007) mentioned a few basic issues surrounding them. Barcodes require line of sight for scans, they can only be scanned one item at a time, if barcodes are dirty or smudged then it cannot be

identified and manual tracking has to be performed therefore it is vulnerable to human error.

RFID and barcodes are soon to be replaced or merged by the new fourth industrial revolution breakthrough technologies for raw material traceability, in supply-chain management. Waughray and de Cleene, (2019) state that technologies such as the internet of things (IOT), blockchain, food sensing technologies. Big data is also a factor that will have to be considered. The IoT will bring a new dynamic between organizations allowing for a new co-operative function between food producers, transportation, and retail companies allowing them to work together. This co-operative function would ensure efficient delivery and food safety. This allows companies involved in the supply chain to have real-time visibility of products and enabled automation of intelligent actions required to ensure optimal food quality, punctual delivery of products, and that these products are prepared in ideal conditions (Waughray & de Cleene, 2019).

Raw Material Traceability

With definitions already being dealt with in the introduction; traceability can be seen as a risk management measure that emphasizes aspects ranging from food safety, food defense, food frauds to the right of the customers need to know (Chhikara et al., 2018). Chhikara et al., (2018) note that effective traceability can yield great benefits for organizations. Potential risks and costs concerning foodborne diseases could be reduced as well as the elimination of food safety hazards. Kraisintu, and Zhange (2011) state that current technologies being implemented in traceability systems include RFID, alphanumerical codes, bar codes, GIS, and GPS.

Chhikara et al., (2018) state that there are also quick control measurements in place to deal with cases that may involve the deliberate contamination in the contents of food products. These control measurements include trace-forward and trace-back (reverse supply chain management). Karamchandani and Srivastava, (2017) described reverse supply chain management as effectively implementing the sequence of events involved in recovering products from a phase of the forward supply chain either for disposal or recovering value. Reverse supply chain management consists of a series of steps that need to be followed to effectively recover products (Karamchandani & Srivastava, 2017)

South African Context

South Africa is renowned for the exports of its fruits and vegetables, especially in grapes for the exporting of wines. Mugadza, (2014) state that the fresh fruits and vegetables were partially traceable in South Africa. He further states that consumers within South Africa prefer to purchase food products that retailers can trace-back to the place of birth (farm); regardless of price. The effect of not being able to trace back can be devastating at times for companies. The Tiger Brand suffered a huge cost with regards to the listeriosis outbreak. The fact that they couldn't trace-back and find the point of contamination, all products had to be disposed of, resulting in financial losses, reputational damage, and lack of customer trust (Khumalo, 2018; Johnston, 2019).

Related Studies

In critically analyzing related studies, a few common issues arose concerning the traceability of raw materials. Bulk and silo storage was a common factor that arose; this is concerning raw materials where a product tag is impossible to attach. An example of such products would include raw materials such as rice or wheat. In addition to these issues such as supplier identification and loss of raw materials during manufacturing also appear as common issues. Lastly, issues such as lot identification, lot-sequence-mixing, and lot-end-mixing appear in the literature. Lot-sequence-mixing relates to processes that entail several buffers or the mixing of raw materials. Lot-end-mixing relates to material flows that differ and process steps that include reflux flows (Zhang & Bhatt, 2014)

Theoretical Framework

The study adopted the TOE framework to explore the factors affecting the adoption of emerging technologies in the traceability of raw materials in the retail industry. Tornastzky and Fleischer (1990) developed the framework to understand factors affecting technology adoption in organizations. Baker, (2011) adds that the TOE framework is an organization-level theory that explains the three TOE (technological, organizational, and environmental) factors that affect technology adoption in organizations.

Technological Factors

Baker, (2011) states that the technological context consists of all technologies already being implemented currently within organizations and as well as those technologies not being implemented but are available to purchase within the marketplace. He further stated that the existing technologies being applied in processes are of the utmost importance when it comes to the adoption of new technologies as a broad limit on the scope and pace of technological change is applied. Kinuthia, (2015) further states that the technological context refers to the decision strategy of technological adoption concerning the current technologies available at the company and the compatibility of existing and new technologies. The six technological variables include relative advantage, perceived benefits, cost, compatibility, organizational capabilities, and technological resources available.

Organizational Factors

Baker, (2011) states that the organizational context refers to the characteristics of a business. The characterizes of the business play a big role in the manner in which organizations adopt technologies. Arnold, Veile, &Voigt, (2018) state that the size of the firm influences how organizations adapt to innovations. Firm size is one of the biggest organizational factors which affect the rate of adoption within firms. The bigger the firm the more people that need to be trained and the more complex things get. It is stated that larger companies usually have the required resources for adoption but in turn, also have a larger risk factor. Top management support is of the utmost importance for companies when adopting innovations. Mwambia (2015) states that organizational readiness relates to how well-prepared organizations are in adopting new technologies. Factors existing within organizational readiness would include

staff skill and knowledge, resources available, and tension for change. Alam, Ali, & Jani (2011) further state that the readiness of an organization resembles the company's technological capabilities.

Environmental Factors

Baker, (2011) states that the environmental context speaks about how the market industry is structured, technology service providers, and the governing environment. The author further states that competition sometimes triggers the need for adoption within organizations to keep up with their competitors. Laws and regulations also play a big role in the manner in how organizations adopt emerging technologies.

When discussing the environmental factors of IT adoption within businesses, competition is seen as one of the most important predicting factors (Arnold, Veile, & Voigt, 2018). Kinuthia and Chung, (2017) add that competitive pressure influence the adoption of emerging technologies. They defined competitive pressure as the amount of pressure an organization receives from its competitors within the industry they operate. Environmental uncertainty relates to the various uncertainties happening within the environment a business operates. Such uncertainties would include unstable exchange rates and share prices and changes in customer demand. Nothing within the environment is stable as the world is ever-changing (Arnold, Veile, & Voigt, 2018).

Research Methodology

The research design type applied throughout this research article was a systematic literature review. This allowed for the identification of research questions and objectives. Jokonya (2015) stated that systematic literature reviews look to address relevant topics by identifying, critically evaluating, and integrating the findings. The author further states that systematic literature reviews are characterized by being objective, systematic, transparent, and replicable. Jokonya (2015) also states that there are five key stages when doing a systematic review; these are namely scoping, planning, identification, screening, and eligibility.

The research type was quantitatively based on content analysis of existing secondary data from the literature. Content analysis forms part of many procedures for the systematic, replicable analysis of data (Rose, Canhoto, and Canhoto, 2015). It involves the classification of data via the application of a structured. Content analysis provides a structured manner of analyzing data that are generally unstructured and open-ended (Jokonya, 2015).

Unit of analysis

Babbie and Mouton, (2005) state that the unit of analysis, also known as the unit of observation, can be defined as the "what" of your study. Therefore, what object phenomenon, entity, process, or event. The unit of analysis for the study was retail organizations. Kumar, (2018) defined organizations as groups, which are formally structured which include corporations, religious groups, colleges, and so forth. The study explored the factors affecting organizations from adopting emerging technologies.

Instrument Development

The study adopted the TOE framework to achieve the research objectives and answer the research questions. The study explored technological, organizational, and environmental factors variables (Table 1.) affecting the adoption of emergent technologies from identified suitable articles published from 2013-2019. The study used a literature matrix based on an excel spreadsheet to code the existence of construct variables listed in Table 1.

Table 1. TOE Variables

Technological	**Organizational**	**Environmental**
Relative advantage	Firm size	Competition
Perceived benefits	Management support	Environmental uncertainty
Cost	Organizational readiness	Government
Compatibility	Org. performance	Industry Sector
Org. capabilities	Organization structure	Supply chain partners
Resources available	Supply chain strategy	

Data sources and sampling

Convince sampling was used to select suitable articles for the study based on the predefined criteria. Etikan, (2016) defined convenience sampling as non-random sampling were those included in the target population, who meet required criteria at a given time or the readiness to participate. Keywords were used to search for relevant literature, using keywords such as raw material traceability, and digital supply chain management, and fourth industrial revolution among others. The selected published articles from existing literature were published from 2013-2019. Data collection involved the use of search engines such as Google, Google Scholar, Science Direct, and Research gate to select suitable articles.

Research Method

The study adopted quantitative content analysis to explore factors affecting to explore the factors affecting the adoption of smart technologies for traceability of raw materials in the retail industry. The quantitative content analysis helps to transform qualitative data (text) to be analyzed quantitatively (Jokonya, 2015). Quantitative content analysis has eight key steps that researchers follow, which are developing the research question, conceptualization, sampling and unitizing, coding scheme development, data collection, coding, reliability rest and analysis, and findings and conclusions.

Data analysis

Data collected from 62 published articles were categorized based on the TOE framework constructs (technological, organizational, and environmental) before coded and captured in an excel spreadsheet. After the data transformed through coding is was analyzed using a statistical package to produce descriptive statistics which are part of the study results

Study Results
This sub-section presents the results of analyzed data from published articles on smart technology adoption for traceability of raw materials in the retail industry published from 2013 – 2019. The results presented in this section include the demographic data (year of publication, the region of publication, and the research method used for the study) and the TOE theoretical framework construct (technological, organizational, and environmental factors) variables.

Demographic Data
The sub-section below presents the frequencies of the demographic data (year, region, and research method) results on smart technology adoption for traceability of raw materials in the retail industry published from 2013 - 2019.

Articles by year
This sub-section presents the frequencies of the publication year on smart technology adoption for traceability of raw materials in the retail industry published from 2013 - 2019. The show that 2013 had (8%), 2014 (8%), 2015 (11%), 2016 (15%), 2017 (13%), 2018 (24%) and 2019 (21%) of the 62 published articles. The study results indicate there was a general increase on articles related to smart technology adoption for traceability of raw materials in the retail industry from 2013 – 2019.

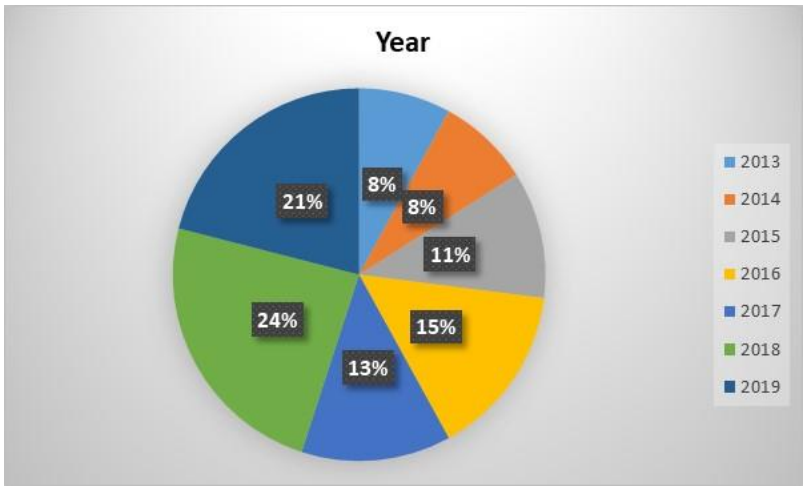

Figure 1: Publication year

Articles by Region
This sub-section presents the frequencies of the publication by region on smart technology adoption for traceability of raw materials in the retail industry published from 2013 - 2019. The show that Africa had (21%), Asia (39%), Europe (21%), and America (19%) of the published articles. The study results indicate Asia had the highest published articles related to smart technology adoption for traceability of raw materials in the retail industry from 2013-2019 and America the least number of articles.

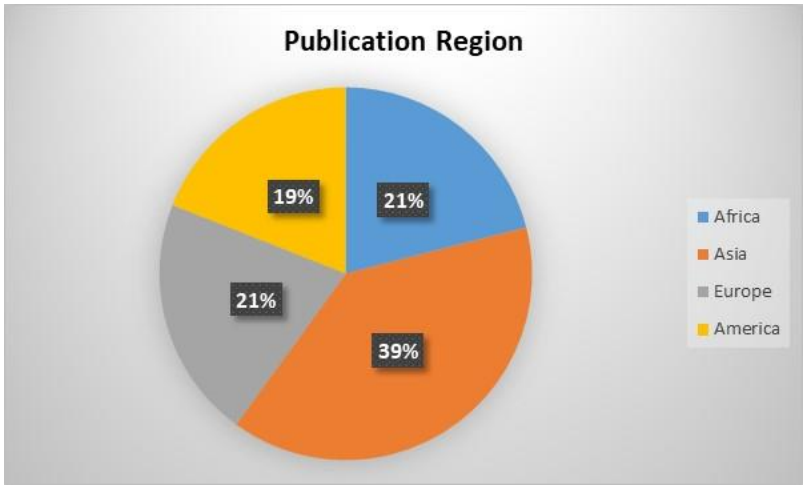

Figure 2: Publication region

Articles by Method

This sub-section presents the frequencies of research methods used in articles published on smart technology adoption for traceability of raw materials in the retail industry published from 2013 - 2019. The show that quantitative had (42%), qualitative (35%), and mixed-method (23%) of the published articles. The study results indicate quantitative was the most used research method on published articles related to smart technology adoption for traceability of raw materials in the retail industry from 2013-2019 and mixed-method was the least used research method.

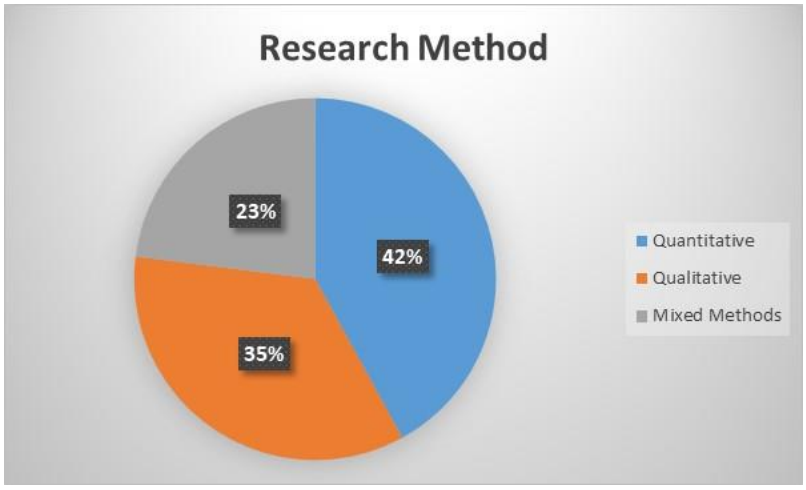

Figure 3: Research Method

TOE Framework Results

The sub-sections below presents results on the TOE framework constructs factors variables that affect the adoption of smart technology for traceability of raw materials in the retail industry published from 2013 – 2019.

Technological Factors

This sub-section presents the frequencies of technological factors variables that affect the adoption of smart technology for traceability of raw materials in the retail industry published from 2013 - 2019. They show that relative advantage (18%), perceived

benefits (47%), cost (35%); compatibility (32%); organizational capabilities (10%), and resources available (46%) of the published articles. The study results indicate that technological factors variables frequencies were less than fifty percent with perceived benefits the highest frequency and organizational capabilities the least frequency of published articles related to smart technology adoption for traceability of raw materials in the retail industry from 2013-2019.

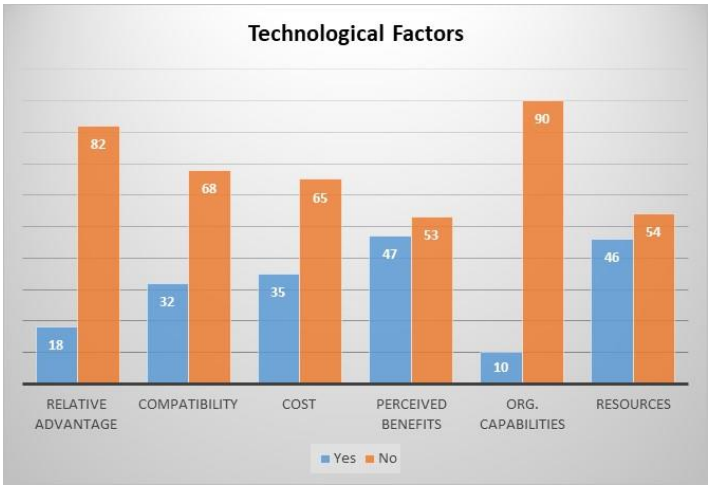

Figure 4: Technological Factors

Organizational Factors

This sub-section presents the frequencies of organizational factors variables that affect the adoption of smart technology for traceability of raw materials in the retail industry published from 2013 - 2019. The show that firm size had (32%), top management support (55%), organizational readiness (35%), organizational performance (15%), organizational structure (45%), and supply chain strategy (24%). of the published articles. The study results indicate top management support organizational factor variable the highest frequency and organizational performance variable the least frequency of published articles related to smart technology adoption for traceability of raw materials in the retail industry from 2013-2019.

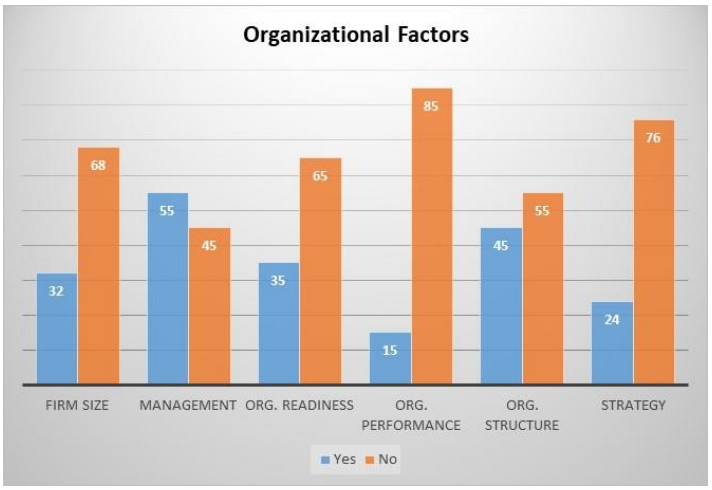

Figure 5: Organizational Factors

Environmental Factors

This sub-section presents the frequencies of environmental factors variables that affect the adoption of smart technology for traceability of raw materials in the retail industry published from 2013 - 2019. The show that competition had (44%), environmental uncertainty (45%), government regulation (41%), industry sector (32%), and supply chain partners (24%) of the published articles. The study results indicate that environmental uncertainty environmental factor variables had the highest frequency and supply chain partners the least frequency of published articles related to smart technology adoption for traceability of raw materials in the retail industry from 2013-2019.

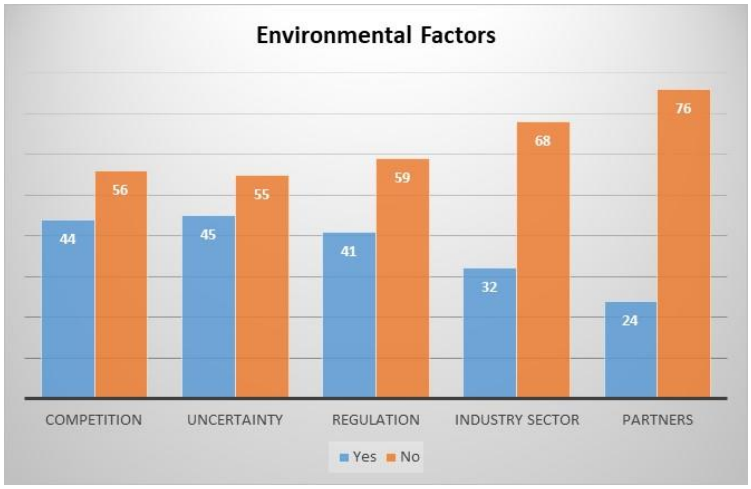

Figure 6: Environmental factors

Discussion and conclusion

The study explored factors affecting the adoption of emerging technologies for raw material traceability in the retail industry using content analysis. From the demographic data perspective, the study results indicate there was a gradual increase in articles related to smart technology adoption for traceability of raw materials in the retail industry from 2013 – 2019. The study results show that Asia had the highest published articles related to smart technology adoption for traceability of raw materials in the retail industry. Besides, the study results indicate quantitative was the most used research method on published articles related to smart technology adoption for traceability of raw materials in the retail industry.

From the TOE Framework constructs, the study results indicate that technological factors variables frequencies were less than fifty percent with perceived benefits had the highest frequency and organizational capabilities had the least frequency of published articles. The study results indicate top management support the organizational factor variable with the highest frequency and the organizational performance variable had the least frequency of published articles. The study results indicate that environmental uncertainty environmental factor variables had the highest frequency and supply chain partners had the least frequency of published articles.

In conclusion, the study achieved its objective of exploring the factors that affect the adoption of smart technologies for raw material traceability in the retail industry. The study contributes to the body of knowledge on factors that affect the adoption of emerging technologies for raw material traceability in the retail industry. Despite the highlighted contribution, the study had also limitations worth mentioning. The convenience sampling adopted by the study makes it difficult to generalize the results. However, the limitation, provide an opportunity for further research on factors that affect the adoption of smart technologies for raw material traceability in the retail industry.

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