



An information delivery model for banking business



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ABSTRACT

Banking is an enterprise consists of different levels of users with the requirement of different levels of information. We propose an information delivery model for banking business which takes information from business analysis and finds the best user for this information with respect to criteria and delivers the multi criteria reporting. There are many multi criteria decision making techniques [MCDM] available to find the best alternative in MCDM problem. We applied fuzzy MCDM technique which resolves inconsistency and uncertainty issues involved in decision making of information delivery for bank users. This model classifies most preferred user to least preferred user for the given information using fuzzy score. This information delivery model and its layers can be applied to other domains to build information delivery model.

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1. Introduction

Information delivery with customization is an important part of Business Intelligence (BI) (Martin, Lakshmi, & Venkatesan, 2012). A typical business intelligence model consists of many number of components in which reporting is very important. This research addresses reporting component of business intelligence for customized information delivery (Skriletz, 2003). It is very important to deliver the information to users according to their requirement (Simperl et al., 2010). Our proposed model handles this problem efficiently. The main objective of this information delivery model is customized reporting which finds relevant information based on the criteria and delivers the information as preferred by user (Hayashi, Hsien, & Setio, 2010; Phan & Vogel, 2010). For a case study, we have taken banking business (Nadeem & Jaffri, 2004) and we have applied fuzzy multi criteria decision support (FMCDS) (Chen, Hwang, & Frank Hwang, 1992; Liu, Chen, Kang, Ngai, & Li, 2005) technique to find the best alternate for this customized reporting.

In normal reporting, the information is presented as report to user's independent of their requirements. In most of the cases, users receive information that is not of their interest. Finding the user's current context and providing them information accordingly could be a challenging task. Reporting is very important in the enterprise information processes and it is very much essential in decision making. Presenting to the user, the information of his interest alone will

be very efficient. This is delivering the right information to the right user through right channel. It prevents inappropriate usage of information by unauthorized users. This information delivery model is known as personalized information delivery.

Traditional methods are not suitable for information delivery due to the drastic growth in the complexity within an enterprise which leads to a number of new information delivery models (Bin & Zuoquan, 2000; Song, Zhang, & Xu, 2009; Zhao & Wang, 2010). Traditionally, analytic hierarchy process (AHP) was used to identify the right alternative for the right information in the information delivery systems. AHP does not take into account the uncertainty associated with MCDS, a fuzzy multi-criteria decision support (FMCDS) procedure can be applied to resolve the uncertainty (Lau et al., 2003).

This research applies FMCDS to banking enterprise and decides the right information for the right user. In banks, users can get information as they like. Confidentiality of information will always be maintained in banks. what extent the information should be given to the user is not well defined (Anisseh & Yusuff, 2011; Carlsson & Fuller, 1996; Li, 2005). To resolve this fuzziness, FMCDS is applied to banking business to develop a customized report according to the user requirements.

The rest of the paper has been organized as follows: Section 2 describes the prior research on information delivery systems and multi criteria decision making techniques, Section 3 describes the research proposal, Section 4 designs the banking information delivery model and its layers, Section 5 describes multi criteria reporting and addresses the uncertainty and inconsistency in customized reporting, Section 6 explains the working procedure of fuzzy AHP with running example of finding best alternate user for this

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information delivery model, Section 7 discusses the results and Section 8 concludes the paper.

2. Literature survey

Technological innovations provide abundant information in the organization. An organizational process consists of data, technology and users. An organization has different levels of users and the informational need of users differs from one to another. Organizations need appropriate process, technology and tools to find the right information to the right people and to deliver the information at the right time.

This literature survey describes previous work on information delivery systems, its applications and the information delivery systems available for banking business. This section also describes technologies available for the development of information delivery systems.

2.1. Information delivery systems

Information delivery systems (IDS) have been implemented in various domains including tourism (Hinze & Voisard, 2003; Hinze, Voisard, & Buchanan, 2009; Sharma, Singh, & Singh, 2011) education (Garner, Harwood, & Sullivan, 2001; Harrington, Reeves, & Oliver, 2005; Stone, 2009), disaster management (Hasegawa, Sato, Matsunuma, Miyao, & Okamoto, 2005), emergency department (Thompson, Yarnold, Williams, & Adams, 1996) and so on.

Tourism information provider (TIP) delivers information accumulated from user location, time, and profile of the user to mobile devices. This system uses hierarchical semantic geospatial model to accumulate knowledge about the users (Hinze & Voisard, 2003). The semantic rich Tourist Information System (TIP) provides semantically rich information instead of static information about sights and places. It addresses issues in personalization of the information delivery to each traveller according to his travel history with his interest (Hinze et al., 2009). A location-based information delivery system for tourism provides information in context to user location, user preferences, time of day, and type of device (Sharma et al., 2011).

In education domain, information delivery is considered as one of the innovative techniques to improve online learning (Harrington et al., 2005). IDS can provide education content according to the student demand (Stone, 2009). To access the scholarly information at reasonable cost with fast access, an information delivery model has been designed which uses e-print servers (Garner et al., 2001).

Information delivery system has been applied in emergency areas such as disaster management and patient emergency management. The multilingual disaster information delivery system delivers information to mobile phones using graphic text (Hasegawa et al., 2005). Information delivery has a different meaning when it is applied to "Patient Satisfaction in Emergency Department". Typically, it is measured from the explanation of procedures and delays when a patient is in an emergency situation (Thompson et al., 1996).

Distributed event-driven continual query system (OpenCQ) is an information delivery system which exhibits push-enabled, event-driven and content-sensitive information delivery capabilities. OpenCQ delivers the information to the relevant users when change occurs by the execution of events. These events are decided by the user interest (Liu, Pu, & Tang, 1999).

To improve the performance of information delivery, filtering methods have been applied in developing personalized information delivery systems (Foltz & Dumais, 1992). A typical information delivery system may contain elements such as data integration (in

what context – information from one place to another place), delivery (right user based on user profile), filtering (right information, right user and right time) and intelligence (knowledge about 'must have', 'need to know' and 'nice to know') (Datamonitor, 2003).

From prior researches, it is known that the information delivery system has a wide opening for its development. An efficient information delivery can solve information overload by its customized reporting and IDS can be applied to other domains. The next section describes prior research on IDS in banking business.

2.2. Information delivery in banking

In banking, information delivery systems have been applied to offer various financial services to customers. IDS has been designed for retail banking which considers two factors, such as type of delivery channels and number of delivery channels. The banking services differ according to the technologies available for delivery and type of delivery channels available. A framework has been proposed to find the relationship between service content characteristics and service delivery channels (Huete & Roth, 1988).

A multi-channel service delivery system consists of a physical channel and a virtual channel for a bank. Physical channel is further classified into sub channels, such as self-service channel – Automatic Teller Machine (ATM), and employee service channel – Branch/Teller and Branch/Platform Sales Representative. Likewise, virtual channel is classified into Internet, Voice Response Unit (VRU) and Call Centre. The performance of the firm is influenced by utilization of self-service channels in a multi-channel service delivery system (Xue, Lorin Hitt, & Harker, 2007).

Literature on prior research indicates non availability of information delivery model for banking business. Designing of information delivery model involves many factors such as banking users, banking information, delivery channels, information security and so on. Multi choice decision problems can be solved using multi criteria decision making techniques including analytic hierarchy process (AHP), fuzzy AHP (FAHP), TOPSIS, ELECTRE, Grey Theory, etc. The next section discusses various multi criteria decision making techniques and their applications.

2.3. Multi criteria decision making techniques and their applications

Multiple-criteria decision-making is a sub-discipline of operations research that explicitly considers multiple criteria in decision-making. In our daily and professional lives, there are multiple conflicting criteria to be considered in decision making. For example, in purchasing a car, cost or price is usually one of the main criteria. Quality is typically another criterion that is in conflict with the cost. Some of the criteria we consider while purchasing a car are cost, comfort, safety, and fuel economy. It is unusual to have the cheapest car to be the most comfortable and the safest. Different situations have different criteria to be considered and these criteria differ according to the users (Jin & Zhang, 2009; Kavitha & Vijayalakshmi, 2010; Ölçer & Odabaşı, 2005; Özcan, Çelebi, & Esnaf, 2011).

Many techniques are available to solve multi criteria decision making problems, which find the best alternatives by considering criteria and alternatives (Mateo, 2012; Zeleny, 1982). Table 1 describes various applications of MCDS in finding the best alternative.

In Table 1, it is known that fuzzy occurs very often in various business organizations when multiple choices are available. ELECTRE is used to reach close to the positive and move off from the negative points (Saeed Zaeri, Sadeghi, & Naderi, 2011). In some applications, uncertainty in decision making arises. Hence, fuzzy multi criteria decision making is chosen to solve this issue. The

Table 1
Applications of multi criteria decision making techniques.

Application	Author and year	Alternatives	Criteria	Problem	Techniques	Best alternative
Location planning for urban distribution centre under uncertainty	Awasthia et al. (2011)	3 different areas, A1 A2 A3	1. Accessibility, 2. Security, 3. Connectivity to multimodal transport, 4. Costs, 5. Environmental impact, 6. Proximity to customers, 7. Proximity to suppliers, 8. Resource availability	Location planning for urban distribution centre is vital in saving distribution costs and minimizing traffic congestion arising from goods movement in urban areas.	TOPSIS	A1 > A3 > A2. A1 – best area
MCDM approach to garment matching problem	Ding et al. (2011)	65 trousers with the same colour, style and material for female are studied	Waist girth (W), hip girth (H), and trousers length (L)	To solve the large scale garment matching problem where size fitting problem is a main obstacle to large scale garment sales and online sales because it is difficult to find the fit garments by the general size information	Co-evolutionary immune algorithm	Product which satisfies the “customer satisfaction and service quality”
Comparative analysis of MCDM methodologies	Özcan et al. (2011)	Warehouse A, B, C and D	Unit price, stock, holding capacity, average distance to shops, average distance to main suppliers, movement flexibility	To find the best warehouse location	AHP, TOPSIS, ELECTRE and Grey Theory	Warehouse – D
Environmental risk assessment	Rezaian and Jozi (2012)	Power plant Location 1 Location 2 Location 3 Location 4	1. Environment of the power plant, 2. Health-safety risks, 3. Technological risks, 4. Affected environment risks	To find the best location for the construction of power plant	AHP	Location 3
Training performance and evaluation of administration sciences instructors	Nikoomaram et al. (2009)	Instructor A, B, C and D	1. Teaching style, 2. Individual features and social relation, 3. Knowledge level, 4. Observance of educational regulations 5. Educational tools.	To find the best trainee and the performance of the administrative science instructors	FMCDs	Instructor A
Power customer satisfaction and profit making	Medjoudj et al. (2013)	A1, A2, A3 and A4	Cost, reliability, availability, maintainability and power quality	To investigate appropriate tools to achieve the goals	AHP	A2
Enhancing information delivery in extended enterprise networks.	Lau et al. (2003)	P1, P2, P3, P4, P5 (information receivers)	1. Partner's price range 2. Partner's interest to information 3. Partner's product range	To find the best supplier for mould and die manufacturing.	FMCDs	P2
Evaluating anti-armour weapon	Shu-Hsien and Kuo-Chung (2000)	Dragon Milan and sword (weapon systems)	1. Basic capability 2. Fight capability 3. Logistic maintenance 4. Electronic system	To evaluate the non-quantitative factors where decision making is complex.	FMCDs	Sword

criteria that are used in urban distribution centres are security, accessibility, cost and environment (Awasthia, Chauhanb, & Goyal, 2011). The sensitivity analysis is performed to determine the influence of criteria and weights on location planning, which is applied to find the suitable locations. Fuzzy MCDM has been applied for safety assessment where the urge of safety is obtained by having good alternatives and criteria (Schinas, 2007).

The co-evolutionary immune algorithm for the multi-criteria decision making is used to solve the large scale garments matching problem. It is difficult to find the fittest garment while using general size information. Size fitting problem is a main obstacle to large scale garment sales and online garment sales. An immune

co-evolutionary algorithm is used to search the fittest garments from the candidate garments in the stock (Ding, Hu, & Zhang, 2011).

AHP method has been applied in the analysis of health-safety and environmental risk assessment of refineries while selecting the location of the power plant (Rezaian & Jozi, 2012). Fuzzy MCDM is an approach for evaluating decision alternatives which involves subjective judgments by a group of decision makers (Nikoomaram, Mohammadi, Javad Taghipouria, & Taghipourian, 2009). Customer satisfaction and profit making are the goals of electrical power producing and distributing companies. MCDM techniques have been applied to aid the decision makers to achieve these goals (Medjoudj, Aissan, & Haim, 2013).

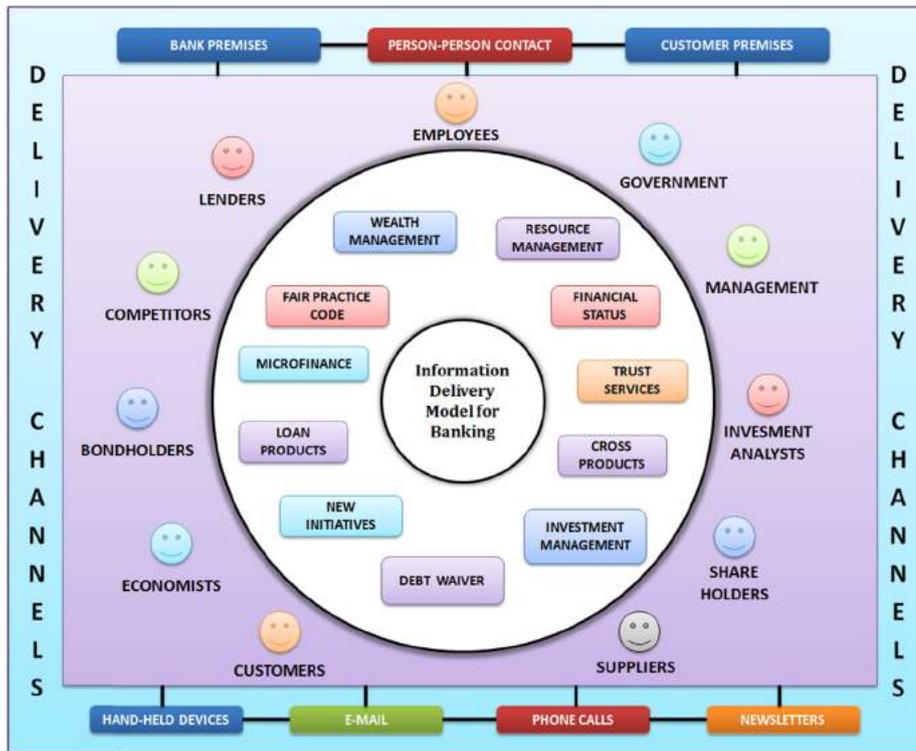


Fig. 1. Information delivery model for banking with its elements.

To understand the characteristics of MCDM methods (AHP, TOPSIS, ELECTRE (I, II, IS, III, IV and A), Grey Theory), a case study on warehouse selection using these MCDM methods has been conducted. MCDM techniques have been applied in domains such as mould-die industry (Lau et al., 2003), military (Shu-Hsien & Kuo-Chung, 2000) and nutridar factory (Dalalah, Hayajneh, & Batieha, 2011) to select an optimal decision for the enterprise.

2.4. MCDM in banking business

In banking domain MCDM techniques have been applied to find the best alternative. The largest five commercial banks of Turkish banking sector have been examined and these banks are evaluated in terms of several financial and non-financial indicators. FAHP and TOPSIS have been applied to analyze the performance of the banks (Seçme, Bayrakdaroğlu, & Kahraman, 2009). From the four perspectives of balanced scorecard, FAHP was applied to calculate the relative weights of banking performance evaluation indices. MCDM techniques SAW, TOPSIS and VIKOR have been applied to improve the gaps of banking (comparing with another bank) to achieve the desired level with the ranking of indices (Wu, Tzeng, & Chen, 2009). Fuzzy AHP has been applied successfully to prioritize the factors that influence e-banking development in Iran (Haghighi, Divandari, & Keimasi, 2010).

Banking sector has a wide scope for reporting activities and it involves a wide variety of stake holders in different formats. When a user wants to collect information from the bank, the level of information or the extent to which the information has to be given is not consistent. Moreover, delivery channels influence the level of information and each user has different preferences over delivery channels. In order to find the right user for the right information in banking, we used fuzzy AHP in our proposed model to solve ambiguities (right user, right information, and right delivery channel). The working model of FMCDS for banking describes the relation between information, users and delivery channels. The next

section describes research proposal of this information delivery model.

3. Research proposal

This research designs and develops the information delivery model for banking using fuzzy multi criteria decision making. This information delivery model studies and identifies various elements to be considered for the well-organized delivery of information according to the user in banking business. The various elements of this information delivery model are banking information, users of banking, delivery channels of banking, and criteria to be applied to customize the essential information. This information delivery model obtains information from business analysis and develops the report (customizes the information) according to the user's criteria and delivers the customized reporting. This information delivery model considers four criteria to deliver customized information, such as level of information, interest of information, speed of delivery and level of security. Finally this information delivery model finds the best alternate user to receive the information using the fuzzy multi criteria decision making technique and then delivers the multi criteria reporting. The next section describes the layers of this information delivery model for banking business.

4. Banking information delivery model and its layers

Based on the analysis of information delivery systems (Hinze & Voisard, 2003; Hinze et al., 2009; Sharma et al., 2011) an information delivery model for banking has been designed as depicted in Fig. 1.

This information delivery model includes elements such as banking users, banking information, delivery channels and criteria. The essential elements that are required to form an information

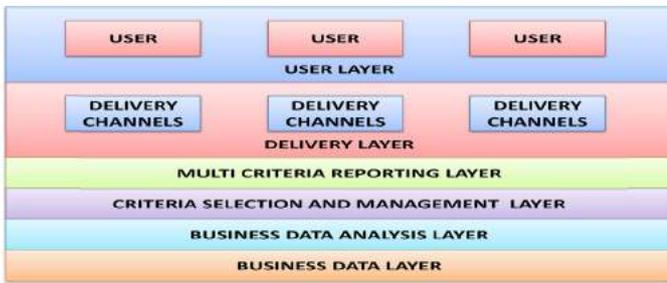


Fig. 2. Layers of information delivery model.

delivery model for banking have been structured in this model. In Fig. 1, the inner most circle encompasses all the elements of information delivery model. The next circle includes all the banking information along with the banking users. The next layer includes the criteria that customize the information. The final layer consists of the information delivery channels which deliver the right information to the right user. The concrete layers of this delivery model have been designed from its elements along with business data and analysis. The layers of this information delivery model are depicted in Fig. 2.

This information delivery model starts with data layer, business data analysis layer which analyses the business data and provides reporting. Instead of a common report, a customized report has been designed using ‘criteria selection and management layer’ and ‘multi criteria reporting layer’. The criteria selection and management layer finds, analyses and selects the criteria according to the information, user and delivery channel. The next layer is multi criteria reporting layer which finds best alternative user among other alternatives. In this banking information delivery model, we used fuzzy multi criteria reporting technique to find the best alternative user. The multi criteria reporting layer develops the customized reporting and passes it to the next layer which consists of delivery channels. The top layer in this model is user layer which receives the customized reporting from the delivery layer. The layers of this model can be applied to other domains to implement information delivery. The next section describes multi criteria reporting.

5. Multi criteria reporting

The objective of this information delivery model is delivering of a customized report called as multi criteria reporting. The core idea of customized reporting originated from business analysis process. In any domain business analysis process starts from data collection and continues until to analysis and report. This analysis may find a new business opportunity, a new business strategy, analysis of a business performance, and a sales analysis.

All these business analyses require reporting, which may be static report targeting all levels of users. The levels of users are from top management to customers and common users. Contrary to normal business reporting, customized business reporting finds right information to right user at right time. For example, when a bank has undergone bankruptcy, the bankruptcy status information is needed by bank users. The information that is required by a customer, an employee, management and government may not be the same. Similarly, every customer may not be given same information, some may be the most valuable customers and others may not be. For example, information about bankruptcy needed by a customer who has savings account is different from that needed by a customer who has invested a huge amount in that bank for a mutual fund scheme. In any business for any information, the same scenario may arise, such as type of information, level of information, speed of delivery, levels of security and delivery channels of information. In this model the customized report is developed based on

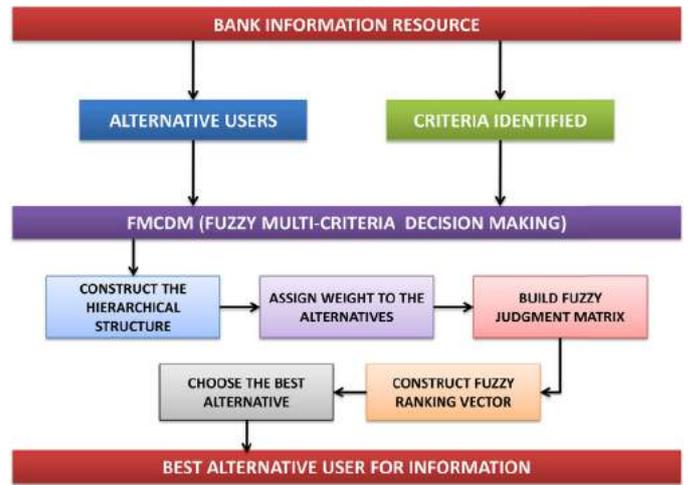


Fig. 3. Flow diagram of FMCD procedure.

banking users, banking information, delivery channels and criteria. Hence this customized report is considered as a multi criteria reporting.

5.1. Uncertainty and inconsistency in multi criteria reporting

In a banking system, information resources, users and delivery channels are available. The goal of this information delivery model is to find the best user for the given information with respect to the given criteria. Information is selected based on the user interest. Once a user’s interest is found, the next option is level of information. All the users may not be given the same level of information and this situation leads to inconsistency. Interest of user may not be same in all situations and user interest may differ from person to person and time to time which leads to uncertainty. To solve uncertainty and inconsistency in multi criteria decision problem, many techniques are available and in this model, fuzzy analytical hierarchy process (fuzzy AHP) has been applied to find the best user to receive the information.

6. Working procedure of fuzzy AHP

Analytical hierarchy process (AHP) is a decision making approach that structures multiple choice criteria into a hierarchy, assesses the relative importance of these criteria, compares alternatives for each criterion and criterion for the goal, and determines an overall priority ranking of the alternatives. It has been applied to multi criteria group decision making domains such as government, business, industry, education and healthcare. It is mainly used in crisp decision applications. AHP does not take uncertainty associated with the mapping of people’s judgement to an evaluation scale. In order to overcome the shortcomings of the AHP, fuzzy set principle is applied to AHP to determine the best alternative. In fuzzy AHP, the weights are expressed by possibility measure or necessary measure. Thus fuzzy multi criteria decision support procedure has been selected and it helps to take effective decisions in banking information delivery model. To find the best user to receive the information FMCD procedure is applied and steps of FMCD have been depicted in Fig. 3.

Fig. 3 describes the various steps of fuzzy AHP which have been applied to find the best user. The various steps involved in FMCD have been applied to the banking system to find the best alternative (user) for the given banking information with required criteria. Each step of FMCD has been experimented, which is described in the following sections.

Table 2
The various receivers of the banking information delivery model.

Customers	Management	Bank users	Shareholders	Regularities
Competitors	General public	Investment analysts	Economist	Consultants
Business partners	Government	Banking marketing professionals	Bondholders	Professional bodies
		Bank employees		

6.1. Choose the alternatives and bank users

In the first step of the fuzzy AHP for the information delivery model the banking users (alternatives), information resources and delivery channels have to be identified. A banking system consists of many users such as customers, management, employees, government, bond holders and so on. The list of identified users for banking is described in Table 2.

Table 2 lists the important users of banking and typically these users are in need of different information. At one level, every user is aware of the required information. Identifying and presenting the users with the needed information are the objectives of this banking information delivery model. Bank and its operations formulate the information repository. Bank information growth is dynamic and continuing. Some of the banking information are described in Table 3.

Table 3 describes various information of banking business. In reality more information is available for banking. To formulate this information delivery model, we have restricted our work to this information. The next step in this information delivery model design is to decide the information delivery channel. According to the choice of information delivery channel, the level of information and visualization of information should be generated. When the user wants to receive the information through email, more content can be delivered whereas the same content cannot be delivered through SMS. The various delivery channels that have been applied in this information delivery model for banking business are described in Table 4.

Information delivery channels play an important role in information delivery. The level of information and the level of security to the information are decided by the delivery channels. Finding the best information delivery channel is an important aspect of information delivery model.

6.2. Identify the criteria

In the second step, different criteria should be chosen. Based on the criteria, the best alternative for banking information should be chosen. Development of customized information, according to the user, depends on the criteria to be applied in that system. In this information delivery model, we applied four criteria to decide the right information and the right user. Table 5 describes the four criteria which we applied in this information delivery model.

Many criteria need to be considered for deciding the customized report. However, information delivery model considers four criteria to decide the customized information. The relationship between these four criteria is depicted in Fig. 4.

Fig. 4 depicts the relationship between criteria applied in this information delivery model. In this model, interest of information and level of information have been considered as user level criteria, and level of security and speed of delivery have been considered channel level criteria. The influence of each criterion is described in the following sections.

6.2.1. Interest of information

In a banking system each user has different interest, and based on the interest, information requirement differs from one user to another. Table 6 describes banking users, interest of information

and the influences of the information on decision making (Riley, 2012) have been described.

Table 6 describes the customer’s general interests of information such as reliable quality, value for money, product availability, and customer service. This interest of information cannot be applied to all the users and it may differ from one user to another.

6.2.2. Level of information

Once interest in information has been obtained, the next level of decision making decides the level of information. Information is decided by the criteria, “interest of information”, whereas the information content is decided by the criteria, “level of information”.

6.2.3. Speed of delivery

When banking users are in need of information, speed of delivery influences the users in getting the information. Priority and the kind of information, from banking user’s perspective, decide speed of delivery.

6.2.4. Level of security

The various criteria for this information delivery model are type of information, level of information and speed of information which is influenced by the level of security. The information to be delivered should be classified such that different levels of security can be applied. The various levels of security are Top Secret, Secret, Confidential, Restricted, and Open. Depending on the information, the level of security should be applied.

Based on these criteria, multi criteria reporting have been developed. The next step explains the construction of hierarchical structure.

6.3. Construct the hierarchical structure

The hierarchical structure is constructed using the goal at level 1, criteria (C) at level 2 and the various alternatives (A) at level 3. The problem is decomposed into a hierarchical structure that is depicted in Fig. 5.

- Level 1: The best alternative is placed at top level.
- Level 2: The various criteria of choosing the alternatives are placed in the second level.
- Level 3: The various alternatives are placed in the third level.

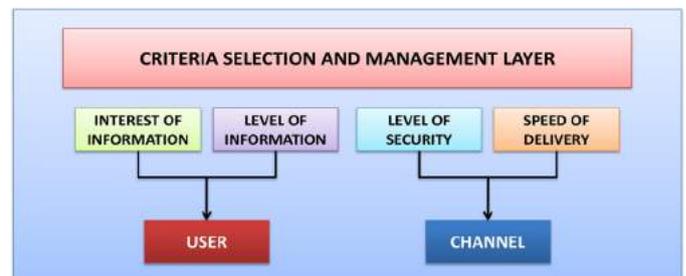


Fig. 4. Relationship between selected criteria.

Table 3
The various information of the banking business.

Loan products (LP)	Cross products (CP)	Bank information resources Banks – shop for insurance	Interest rates on advances (IRA)	Trust services (TS)
Customer relations (CR)	Banking finance services (BFS)	Fair practice code (FPC)	Marketing of banking services	New initiatives (NI)
Trend and progress of banking (TPB)	Forex market information (FMI)	Other services of banks (OSB)	Debit cards (DCD)	Pitch books (PB)
Microfinance (MF)	Bank analytic and advisory activities (BAA)	Banking ombudsman services (BOS)	Credit cards (CCD)	Lending standards (LS)
NRI services (NRI)	Debt waiver (DW)	Interest rates on deposits (IRD)	Investment management (IM)	Bank regulations (BR)
Wealth management (WM)	Bank profit and loss account (BPL)	Bank charges for various services (BCV)	Resource management (RM)	Various types of accounts (VTA)

Table 4
The information delivery channels of banking information delivery model.

E-mail	Hand-held devices	Delivery channels of information delivery model		Phone calls	Newsletters
		Bank premises	Customer premises		

Table 5
Criteria applied for customized reporting.

Interest to information	Criteria applied in information delivery model for customized reporting		Level of security
	Level of information	Speed of delivery	

Table 6
Bank users and interest to information in banking business.

Stakeholder	Main interests	Power and influence
Shareholders	Profit growth, share price growth, dividends	Election of directors
Banks and other lenders	Interest and principal to be repaid, maintain credit rating	Can enforce loan covenants Can withdraw banking facilities
Directors and managers	Salary, share options, job satisfaction, status	Make decisions, have detailed information
Employees	Salaries and wages, job security, job satisfaction and motivation	Staff turnover, industrial action, service quality
Suppliers	Long term contracts, prompt payment, growth of purchasing	Pricing, quality, product availability
Customers	Reliable quality, value for money, product availability, customer service	Revenue/repeat business Word of mouth recommendation
Community	Environment, local jobs, local impact	Indirect via local planning and opinion leaders
Government	Operate legally, tax receipts, jobs	Regulation, subsidies, taxation, planning

6.4. Calculate weight numbers and fuzzy score of alternatives

The decision maker of the organization (banking) assigns weight for each criterion according to his opinion. From the weights assigned by the decision maker, fuzzy weight vector of evaluation criteria is constructed. The fuzzy weight vector W of evaluation criteria is $[\bar{w}_j]$

$$W^T = \begin{bmatrix} \bar{w}_1 \\ \bar{w}_2 \\ \vdots \\ \bar{w}_n \end{bmatrix}$$

where \bar{w}_j is the decision maker's opinion for the relative importance of the j th criterion. Based on the survey which is conducted in various Indian banks each criteria has been assigned the weight, described in Table 7.

In this information delivery model interest of information is given weight of $\bar{6}$, level of information given is weight of $\bar{5}$, level of security is given weight of $\bar{7}$ and speed of delivery is given weight of $\bar{4}$. The weight vector according to the decision maker is describes as,

$$W^T = \begin{pmatrix} \bar{6} \\ \bar{5} \\ \bar{7} \\ \bar{4} \end{pmatrix}$$

After assigning weight to each criterion, weight table should be constructed for each criterion with respect to alternatives and

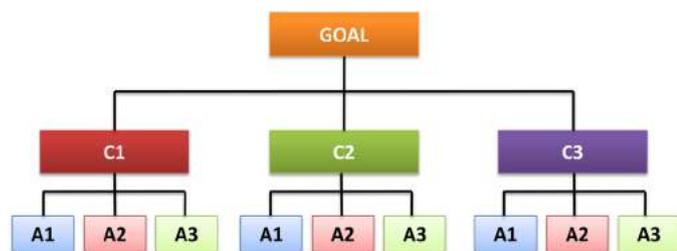


Fig. 5. A typical hierarchical structure to choose best alternate.

Table 7
Assigning weight to criteria applied in banking information delivery model.

Criteria	Weight
Interest of information	$\bar{6}$
Level of information	$\bar{5}$
Level of security	$\bar{7}$
Speed of delivery	$\bar{4}$

Table 8
Weights of various alternatives for the criteria – interest of information.

Alternatives/information ^a	LP	FPC	MF	OSB	WM	IM	RM	TS	NI	PB	LS	BR
Customers	9	5	9	1	1	5	3	1	5	7	3	5
Competitors	7	1	7	1	1	5	1	3	3	1	3	1
Government	9	9	9	3	3	3	3	5	1	1	1	9
Economists	7	9	5	1	3	1	9	1	1	9	5	1
Management	7	7	5	9	9	3	7	9	7	5	7	3
Suppliers	3	5	3	1	3	7	3	1	5	3	1	3
Lenders	4	3	1	3	1	7	1	1	3	3	9	3
Shareholders	5	5	3	3	9	9	1	7	9	6	3	1
Investment analysts	5	7	3	3	7	9	3	3	7	9	5	9
Employees	9	7	7	9	5	1	1	9	3	3	3	5
Bondholders	3	1	5	1	5	3	1	1	3	1	3	1

^a Loan products (LP), fair practice code (FPC), microfinance (MF), other services of banks (OSB), wealth management (WM), investment management (IM), resource management (RM), trust services (TS), new initiatives (NI), pitch books (PB), lending standards (LS), bank regulations (BR).

Table 9
Weights of various alternatives for the criteria – level of information.

Alternatives/information ^a	LP	FPC	MF	OSB	WM	IM	RM	TS	NI	PB	LS	BR
Customers	5	5	4	7	4	7	6	6	5	7	5	5
Competitors	2	3	6	1	1	4	1	3	3	1	3	1
Government	7	6	5	3	3	3	3	5	1	1	1	9
Economists	4	5	8	4	3	3	9	5	1	9	5	1
Management	7	7	3	9	9	4	7	9	7	5	6	3
Suppliers	5	5	4	1	3	7	3	1	4	3	1	4
Lenders	4	3	2	3	1	6	1	2	3	5	9	2
Shareholders	6	3	3	3	8	9	1	3	9	2	3	1
Investment analysts	5	2	3	3	7	8	3	3	7	9	5	6
Employees	3	2	1	9	5	3	2	7	3	3	4	8
Bondholders	4	2	1	1	5	2	1	1	3	1	3	4

^a For abbreviations see legend of Table 8.

information. In this weight table weights are expressed by possibility measure. Considering the criterion “interest to information” and the information “loan product (LP)”, the weight expressed by each alternative (banking users) is described in Table 8. As shown in Table 8, the weight expressed by the customer to loan product is 9, whereas lenders have expressed the weight of 4 and least weight expressed by suppliers to loan products is 3. In the same way for other information such as fair practice code (FPC), microfinance (MF) and other services of banks (OSB), the weight expressed by different alternatives is described in Table 8.

Table 8 describes the different information and the weights assigned by different users based on the criteria interest of information. Likewise the weights assigned to bank information based on the criteria level of information is described in Table 9.

In this information delivery model, “level of information” is an important criterion, which decides the length of the information. The criteria interest of information and level of information are mutually interrelated. Depending on the interest level of the user, the length of information is selected. Table 10 describes different

bank information and the weight expressed by different users based on the criterion speed of delivery.

Tables 8–10 describe weight expressed by decision makers for information and alternatives based on criteria. In the same way, weight table is constructed for the criterion level of security. Depending on the type of information, the level of security is applied. The next step describes construction of fuzzy judgement matrix for each criterion.

6.5. Fuzzy judgement matrix development

The judgement matrices are formulated for all evaluation criteria and alternatives. The fuzzy judgement matrix A of candidate alternatives [A₁, A₂, . . . , A_m] is [ā_{ij}]_{m×n}.

$$A = \begin{bmatrix} \bar{a}_{11} & \bar{a}_{12} & \bar{a}_{1n} \\ \bar{a}_{21} & \bar{a}_{22} & \bar{a}_{2n} \\ \vdots & & \\ \bar{a}_{m1} & \bar{a}_{m1} & \bar{a}_{mn} \end{bmatrix}$$

Table 10
Weights of various alternatives for the criteria – speed of delivery.

Alternatives/information ^a	Loan	FPC	MF	OSB	WM	IM	RM	TS	NI	PB	LS	BR
Customers	7	5	9	1	1	4	3	1	5	7	3	5
Competitors	1	1	7	1	1	6	1	3	3	1	3	1
Government	9	9	9	3	3	3	3	5	1	1	1	9
Economists	7	9	5	1	3	2	9	1	1	9	5	1
Management	7	7	5	9	9	3	7	9	7	5	7	3
Suppliers	5	5	3	1	3	5	3	1	5	3	1	3
Lenders	3	3	1	3	1	4	1	1	3	3	9	3
Share holder	9	5	3	3	9	6	1	7	9	3	3	1
Investment analysts	5	7	3	3	7	4	3	3	7	9	5	9
Employees	1	7	1	9	5	5	1	9	3	3	3	5
Bond holder	3	1	1	1	5	4	1	1	3	1	3	1

^a For abbreviations see legend of Table 8.

Table 11
Judgement matrix for loan product, micro finance and invest management.

Loan product (LP)	Micro finance (MF)	Invest management (IM)
$\begin{pmatrix} \bar{9} & \bar{5} & \bar{6} & \bar{1} \\ \bar{7} & \bar{2} & \bar{4} & \bar{1} \\ \bar{9} & \bar{7} & \bar{5} & \bar{9} \\ \bar{7} & \bar{4} & \bar{4} & \bar{7} \\ \bar{7} & \bar{7} & \bar{6} & \bar{7} \\ \bar{3} & \bar{5} & \bar{6} & \bar{5} \\ \bar{4} & \bar{4} & \bar{6} & \bar{5} \\ \bar{5} & \bar{6} & \bar{7} & \bar{9} \\ \bar{5} & \bar{5} & \bar{4} & \bar{5} \\ \bar{9} & \bar{3} & \bar{2} & \bar{1} \\ \bar{3} & \bar{4} & \bar{3} & \bar{3} \end{pmatrix}$	$\begin{pmatrix} \bar{9} & \bar{4} & \bar{4} & \bar{9} \\ \bar{7} & \bar{6} & \bar{5} & \bar{7} \\ \bar{9} & \bar{5} & \bar{3} & \bar{9} \\ \bar{5} & \bar{8} & \bar{7} & \bar{5} \\ \bar{5} & \bar{3} & \bar{5} & \bar{5} \\ \bar{3} & \bar{4} & \bar{6} & \bar{3} \\ \bar{1} & \bar{2} & \bar{1} & \bar{1} \\ \bar{3} & \bar{3} & \bar{5} & \bar{3} \\ \bar{3} & \bar{3} & \bar{3} & \bar{3} \\ \bar{7} & \bar{1} & \bar{1} & \bar{1} \\ \bar{5} & \bar{1} & \bar{3} & \bar{1} \end{pmatrix}$	$\begin{pmatrix} \bar{5} & \bar{7} & \bar{6} & \bar{4} \\ \bar{5} & \bar{4} & \bar{5} & \bar{5} \\ \bar{3} & \bar{3} & \bar{3} & \bar{3} \\ \bar{1} & \bar{3} & \bar{1} & \bar{2} \\ \bar{3} & \bar{4} & \bar{2} & \bar{3} \\ \bar{7} & \bar{7} & \bar{7} & \bar{5} \\ \bar{7} & \bar{6} & \bar{6} & \bar{4} \\ \bar{9} & \bar{9} & \bar{7} & \bar{6} \\ \bar{9} & \bar{8} & \bar{8} & \bar{4} \\ \bar{1} & \bar{3} & \bar{1} & \bar{5} \\ \bar{3} & \bar{2} & \bar{3} & \bar{4} \end{pmatrix}$

For example, for the loan product information, the judgement matrix is constructed as follows and the judgement matrix is constructed for all the information. For example, consider the information loan product. For this information, weights expressed by different users are taken from each criterion table. For other information in the same way the judgement matrix has been constructed. Table 11 describes judgement matrix for loan product, microfinance and invest management.

The next section describes calculation of fuzzy ranking vector for each of the information in this information delivery model.

6.6. Fuzzy ranking vector is calculated

The final score R of the alternative is calculated using weight vector and fuzzy judgement matrix by using the following equation, $R = A \otimes W^T$, R should be of the form,

$$R = \begin{bmatrix} \bar{a}_{11} \otimes \bar{w}_1 \oplus \bar{a}_{12} \otimes \bar{w}_2 \oplus \dots \oplus \bar{a}_{1n} \otimes \bar{w}_n \\ \dots \\ \bar{a}_{m1} \otimes \bar{w}_1 \oplus \bar{a}_{m2} \otimes \bar{w}_2 \oplus \dots \oplus \bar{a}_{mn} \otimes \bar{w}_n \end{bmatrix} = \begin{bmatrix} \bar{r}_1 \\ \bar{r}_2 \\ \dots \\ \bar{r}_m \end{bmatrix}$$

where \bar{r}_i is the final score of alternative.

The final score R for loan information, microfinance and invest management is calculated by forming fuzzy ranking vector, as described in Table 12.

From this fuzzy ranking vector, the final score R is calculated. From this, mean and spread of the final score (R) are calculated, which is described below.

6.7. Choose the best alternative

By applying fuzzy multi criteria decision making procedure to each of the information against alternatives (users), based on the four criteria the following results are obtained. To every fuzzy

Table 12
Fuzzy ranking vector for loan product, micro finance and invest management.

Loan product (LP)	Micro finance (MF)	Invest management (IM)
$R = A * W^T$ $\begin{pmatrix} 117 & 169 & 265 \\ 87 & 152 & 216 \\ 75 & 120 & 208 \\ 78 & 126 & 199 \\ 87 & 132 & 200 \\ 42 & 82 & 140 \\ 70 & 128 & 216 \\ 62 & 98 & 176 \\ 77 & 130 & 203 \\ 74 & 116 & 201 \\ 37 & 82 & 156 \end{pmatrix}$	$R = A * W^T$ $\begin{pmatrix} 74 & 137 & 238 \\ 66 & 115 & 210 \\ 106 & 163 & 264 \\ 59 & 105 & 187 \\ 53 & 98 & 179 \\ 43 & 75 & 156 \\ 46 & 83 & 167 \\ 42 & 87 & 164 \\ 62 & 106 & 167 \\ 41 & 83 & 166 \\ 75 & 103 & 193 \end{pmatrix}$	$R = A * W^T$ $\begin{pmatrix} 49 & 107 & 199 \\ 37 & 99 & 189 \\ 46 & 80 & 163 \\ 57 & 83 & 175 \\ 58 & 114 & 199 \\ 81 & 199 & 246 \\ 63 & 128 & 236 \\ 89 & 155 & 271 \\ 110 & 168 & 279 \\ 47 & 84 & 167 \\ 29 & 80 & 172 \end{pmatrix}$

Table 13
Best alternate for loan information.

Alternatives	Sum	$\bar{x}(\bar{r}_i)$	$\bar{\sigma}(\bar{r}_i)$
Customers (CS)	551	183	939
Competitors (CT)	455	151	693
Government (GM)	403	134	762
Economists (ES)	403	134	618
Management (MT)	419	139	539
Suppliers (SS)	264	88	404
Lenders (LS)	414	138	900
Shareholders (SH)	336	112	566
Investment analysts (IA)	410	136	667
Employees (EP)	391	130	697
Bondholders (BH)	275	91	601

number (R), the mean and standard deviation are calculated. The fuzzy number which has higher mean and higher standard deviation can be considered to have better performance than other fuzzy numbers. Therefore mean and standard deviation can be used to compare the ranking of the alternatives against information. The alternative with the highest standard deviation among the alternatives is the best one to receive the data.

The mean of the final score is given by,

$$\bar{x}(\bar{r}_i) = \frac{\int x f_{\bar{r}_i}(x) dx}{\int f_{\bar{r}_i}(x) dx} \tag{1}$$

The spread of the final score is given by,

$$\bar{\sigma}(\bar{r}_i) = \left[\frac{\int x^2 f_{\bar{r}_i}(x) dx}{\int f_{\bar{r}_i}(x) dx} - (\bar{x}(\bar{r}_i))^2 \right]^{1/2} \tag{2}$$

This can be re-written as,

$$\bar{x}(\bar{r}_i) = \frac{a + b + c}{3} \tag{3}$$

$$\bar{\sigma}(\bar{r}_i) = \frac{a^2 + b^2 + c^2 - ab - bc - ac}{18} \tag{4}$$

where \bar{r} is triangular fuzzy number (a, b, c), $\bar{x}(\bar{r}_i)$ is mean and $\bar{\sigma}(\bar{r}_i)$ is standard deviation.

The alternative with the highest mean and spread value is chosen as the best alternative. The experimental results have been described in the next section.

7. Results and discussion

Based on the experimentation using fuzzy AHP the following results are obtained. From these results we observe that the alternative with the highest standard deviation is the best receiver of the information. The sum, average and standard deviation for loan products are described in Table 13.

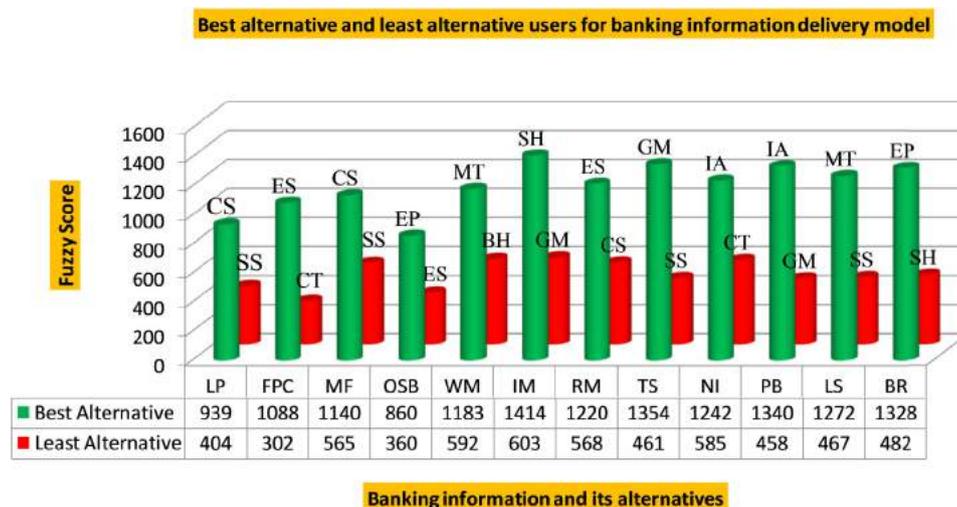
Table 13 describes the matching of information with bank users by FMCDs procedure. From the results, the best alternate [most preferred user] for loan information is customers (CS) with the score of [939] and least preferred user is suppliers (SS) with the score of [404]. Economists (ES) and investment analysts (IA) have normal level of preference on loan products with scores of [618] and [667]. The experimental result shows that information cannot be assigned with specific user. The same information may be required for different users, and the users are differentiated by their interest and adequate level of information required by them. The graph depicted in Fig. 6 indicates the level of preference for loan information in banking domain.

Fig. 6 shows the level of preference users for loan information. When we match the loan information with bank users using FMCDs, the most preferred users are customers and least preferred users are suppliers. Lenders are interested in loan products and

Table 15

The most preferred and least preferred users of banking information.

Bank information	Best alternative	$\bar{\sigma}(\bar{r}_i)$	Least alternative	$\bar{\sigma}(\bar{r}_i)$
Loan products (LP)	Customers (CS)	939	Suppliers (SS)	404
Fair practice code (FPC)	Economists (ES)	1088	Competitors (CT)	382
Microfinance (MF)	Customers (CS)	1140	Suppliers (SS)	565
Other services of banks (OSB)	Employees (EP)	860	Economists (ES)	360
Wealth management (WM)	Management (MT)	1183	Bond holders (BH)	592
Investment management (IM)	Share holders (SH)	1414	Government (GM)	603
Resource management (RM)	Economists (ES)	1220	Customers (CS)	568
Trust services (TS)	Government (GM)	1354	Suppliers (SS)	461
New initiatives (NI)	Investment analysts (IA)	1242	Competitors (CT)	585
Pitch books (PB)	Investment analysts (IA)	1340	Government (GM)	458
Lending standards (LS)	Management (MT)	1272	Suppliers (SS)	467
Banking regulations (BR)	Employees (EP)	1328	Shareholders (SH)	482

**Fig. 9.** Best alternative and least alternative users for banking information delivery model.

can be applied to a user. When user context is considered, the sensitive information should not be delivered to a user when his handheld device is used by others. Before delivering and applying, the information user context should be identified and perspective of the context (user or bank) should be analyzed respectively.

This experiment has identified the best alternative user for banking information whereas the level of information or content of the information is not defined. The level of information differs from one user to another. According to the user, the content of information should be selected. While selecting the level of content for the information, the type of delivery channel in which the information is to be delivered should be given due weight. According to user preference and type of information delivery channel, the information can be formatted with visualization techniques.

Today banks have different kinds of products and services to meet the needs of the customer. Many of the banks know about their customer profile using Know Your Customer (KYC). In the present scenario, most of the banks are not completely aware and fulfil their customer's needs in time by approaching with required information. This information delivery model has been designed for application in banks to approach the customers according to their demand and needs. Bank should not provide all the information to all the customers and confidentiality of the information should be maintained with different levels of security. Information delivery involves various factors such as what information needs to be given, to whom this information should be given, what level of information is to be given and through which means it is to be delivered. To address these factors, this information delivery model has been designed.

In banks information is presented to its users according to their request. The required information is processed from the experience of the respective managerial person who is handling that profile. The biasness of the person preparing the information or report may influence the content of the information. It is very difficult to maintain consistency and standard of information when it is required by different users for their various needs prepared by the bank. In this perspective, this information delivery model can be a substantial replacement for existing way of preparing customized report. To address these issues and to overcome the present practices in banks to prepare the customized report, we have developed information delivery model based on its concepts and models available in other domains. In future, most of the user activity in banking premises would be gradually reduced. In such circumstances, the role of information delivery would be vital.

8. Conclusion

This research has developed a basic information delivery model with customized report for banking users to deliver the right information of their interest. In any information delivery system, information should be processed based on a deep understanding of user's information needs and their interest. The quality and quantity of content delivered by this information delivery model can be improved by applying the principles of information management. Information management includes total management of information and its resources, including identifying, selecting, evaluating, securing and providing access to significant information resources. This information is further refined by applying expert knowledge or by processing of information using knowledge-based systems. It

includes the ability to critically evaluate, select, and filter and format the information resources. The developed information content should adhere to information policies of banks.

Fuzzy multi criteria decision making has been applied efficiently to find the best alternative user for this information delivery model. This model finds the best alternative user for the given information with respect to criteria and delivers the information to the user through the preferred delivery channel. In this research, customized reporting is implemented for selected bank users with limited information and criteria. Business intelligence provides right information at right time to the right user. Its reporting can be enhanced by adding this information delivery model as a component.

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