BEA 100 FINTECH CHALLENGE

Smart Credit Dashboard

Project Report

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Abstract

Although various solutions have been created (HSBC-Xero, Barclays' SmartBusiness Dashboard, etc.) to address Small Medium-sized Enterprise (hereafter written as SME)'s concerns over lack of services from tradition banks, none has addressed SME's difficulty of obtaining credit. This report outlines and examines the Smart Credit Dashboard solution to address such an issue.

This report presents a detailed situation analysis of SMEs in Hong Kong, and two of their biggest concerns are identified: lack of services and difficulty of obtaining credits. Subsequently, the report introduces the design, including technical details and workflows, of the dashboard function which aims to address the first concern. Furthermore, the report also explores the design of the smart credit rating system, including its technical details (API), scoring algorithms, and score normalization (three methods are discussed). This smart credit rating system is designed to address the second concern. In addition, the possibility of integrating machine learning to the credit system is discussed.

Due to the scope of this project, lack of existing APIs and technical infrastructure required, the project's prototype remains at an interface level. However, the key aim of this report is to address and provide a vision for the design, workflow, methods, and implementation of the project. Information such as experimentation, results as well as user feedbacks is impossible to provide without a prototype from phase four[1].

The primary purpose of this report is for readers to have a glimpse of the potential future of SME banking services from traditional banks. Traditional banks continue to face challenges from FinTech start-ups that are tailoring their services towards SMEs, and if traditional banks do not improve their methods, they may lose serious market share [1].

[1] Implementation phases are elaborated under "Implementation phases" section.

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Section 1: Introduction

1.1 Current situations and pain-points of SMEs in Hong Kong:

SMEs are of vital importance to Hong Kong's business landscape. Until December 2018, there are 338,113 SMEs in Hong Kong and over 1.3 million people are engaged by SMEs [2]. SMEs represent over 98 percent of total business and provide about 46 percent of total employment [2]. Considering SMEs' contributions to the Hong Kong economy and future potential, more attention should be paid to SMEs to ensure their continuous and healthy growth.

Description	2018	2017	2016
Increasing costs had a major negative impact on their business	43.0 %	37.7 %	37.3 %
Required funds from an external source	53.4 %	66.5 %	72.7 %
Sought external funds for business growth	52.3 %	55.3 %	51.8 %
Found it easy or very easy to access external finance	12.8 %	23.8 %	19.9 %
A bank was the business's main source of external finance	38.9 %	43.2 %	31.4 %

Fig. 1 Business activity over the past 12 months [3]

As is shown in Fig. 1, a growing number of SMEs reports that increasing costs had a negative impact on their business. To offset the negative impact, SMEs requires external funds but only 12.8 percent of them found it easy to access external finance. In addition, for 38.9 percent of SMEs, banks were their main source to obtain financial support. Therefore, many SMEs are having a difficult time looking for external funds and bank loans are still one of the main sources to get financial support.

Perception on banks' credit approval stance compared with half-year ago	2018 Q3			2018 Q4		
	More difficult	Similar	Easier	**More difficult**	**Similar**	**Easier**
	23%	63%	14%	**22%**	**63%**	**16%**

Fig. 2 Comparison of perceived banks' credit approval stance relative to 6 months ago [4]

Banks' stance on existing credit line	2018 Q3			2018 Q4		
	Tighter	No change	Easier	**Tighter**	**No change**	**Easier**
	2%	91%	7%	**16%**	**64%**	**20%**

Fig. 3 Change in banks' stance on existing credit lines [4]

Results of new bank credit applications	2018 Q3			2018 Q4		
	Not successful	Partially successful	Successful	**Not successful**	**Partially successful**	**Successful**
	6%	11%	83%	**6%**	**38%**	**57%**

Fig. 4 Results of new bank credit applications [4]

However, it is not always easy for SMEs to obtain bank loans. According to Hong Kong Monetary Authority's (HKMA) survey on small and medium-sized enterprises (SMEs)' credit conditions for the fourth quarter of 2018, 22 percent of surveyed SMEs perceived more difficult banks' credit approval stance compared with half-year ago [5]. The shares of surveyed SMEs reporting that banks' stance on existing credit line becomes tighter has increased from 2 percent to 16 percent, and 6 percent of SMEs failed in applying new bank credit [5]. From this survey, we can further conclude that SMEs faces difficulty when they apply for bank loans for their businesses and require more support.

The main reason SMEs are having difficulty obtaining bank loans is that they often lack successful financial records. For banks to grant SME loans, they need SMEs to provide financial records, in order to ensure the borrowers are credible and will not default. However, SMEs sometimes fail to meet the banks' requirement because as relatively new companies, they lack enough transaction histories or financial records. This could lead to the rejection of the banks' loans application or a long time waiting for approval.

The applying process is also annoying because it usually involves tedious paperwork. The paperwork adds burden to not only SMEs but also banks and could lead to long-time processing for loan application.

The first pain-point is shared by both SMEs and banks. SMEs find the loan applying process difficult, and banks find the process costly and time-consuming. Ultimately, banks want more useful information from SMEs so that they can confidently help SMEs' financial needs, and SMEs are eager to show banks they are credit-worthy.

The second pain-point for SMEs is that banks provide limited services for SMEs. For SME owners, they usually have limited financial knowledge. They may be good at their crafts, but when it comes to managing their cashflows, they are in trouble. When they turn to their banks for support, they are often frustrated by the lack of service banks can provide. Bank hotlines or branch managers are not knowledgeable enough

to serve the needs of SME owners or offer them tailor-made suggestions, and SMEs are too small to be allocated a relationship manager.

We summarize the two pain-points and unfulfilled needs into the following table:

Current Pain-Points	Unfulfilled Needs
SMEs: difficult to get loans ***Banks***: costly to conduct credit check on SMEs	***Banks***: more information on SMEs. ***SMEs***: more ways to prove themselves
SMEs: banks provided limited corporate services for SMEs	***SMEs***: More advisory services from banks

Fig. 5 Current pain-points and unfulfilled needs relating to SME banking

1.2 Current solutions to above pain-points

We will use two Hong Kong-based solutions and one international solution as examples to illustrate current solutions in the market for SMEs.

HSBC Partnership with Xero as a local solution:

Xero is a company that offers online cloud-based accounting services to help SMEs' business thrive [6]. HSBC and Xero work together to provide business bank accounts with convenient cloud-based accounting services via open API. Therefore, users can track their HSBC bank transaction information on Xero and this information is accurate, up-to-date and automatically updated [7]. This is a good example of banks' cooperation with third-party services providers. Xero gained more exposure to SMEs and SMEs enjoy the powerful online accounting serviced provided by Xero. However, if an SME has limited financial records, Xero cannot help it to better obtain loans.

Neat as a local solution:

Neat provides an easy online bank account opening service for SMEs [8]. Instead of going through the complicated and strict bank account opening process, SME owners can easily open an account in Neat for their business in a very short time. Moreover, Neat provides a business management dashboard for SME owners to keep track of their business. Neat does not have the license to provide credit to its customers. Therefore, Neat fails to address the concerns of credit.

9SPOKES as an international solution:

9SPOKES is an online dashboard which could display third-party business application data in a simple and intuitive manner [9]. These third-party applications include bookkeeping apps, marketing apps, and analytic apps as well as workforce apps. Using 9SPOKES, SME owners can check all their business information in one

place without switching from one all to another. In order to better manage their business, SME owners can explore more useful applications in 9SPOKES App Marketplace and gain free trails to them. However, 9SPOKES still fails to provide credit support for the SMEs.

	HSBC-Xero	**Neat**	**9Spokes**
Business management dashboard	✘	✓	✓
Third-party services	✘	✘	✓
Interaction between SMEs	✘	✘	✘
Credit rating system	✘	✘	✘
Loan assistance	✓	✘	✘

Fig. 6 Comparison of current solutions' features

1.3 Methodology and tools

Smart Credit Dashboard:

Our product Smart Credit Dashboard has two major features: smart dashboard and smart credit system.
Under smart dashboard, we plan to integrate third-party business applications' information and build up an intuitive and effective interface to present all information. SME owners can quickly register a third-party app account via the Dashboard using bank account, so that they can view their business information on smart dashboard and explore more useful applications from our cooperating third party lists.
Under smart credit system, we collect information from all the third-party application connected to our dashboard by the users and then calculate a score that reflects the resilience and business health of the SME otherwise not conveyed by financial records alone.

Technical tools:

For Smart Credit Dashboard, we will use the following technical tools:

- Open APIs: approach each third-party for cooperation to build up open APIs and APIs for information integration.
- HTML & JavaScript: build up our smart dashboard as a web application using HTML and JavaScript.
- MySQL & PHP: store the whole credit rating system in MySQL database, and use PHP to process the information from open APIs as well as calculating the credit scores.

- Machine learning: after obtaining enough data, we can perform machine learning by first setting up the training model. We choose the white box machine learning and Random Forest will be our method.

Section 2: Dashboard Design

2.1 Introduction

The dashboard is designed for SME owners to have access to additional services that may improve their businesses as well as gain better understandings of their businesses. As one of the biggest issues faced by SMEs is the lack of support and advisory services from traditional banks, the dashboard system aims to improve SMEs' banking experiences by integrating third-party applications that can provide such support and services. Furthermore, the apps that are integrated to the dashboard provide a basis/source of information for the smart credit rating system.

2.2 Functions of the Dashboard

- Provide a variety of business service applications to users
- Display key business data/statistics from various sources (e.g. third-party applications, bank account)
- Portal to the smart credit rating system

2.3 Technical Consideration of the Dashboard

Interface:

For the interface, as the Dashboard will be a website, we propose to use HTML to make the webpage with JavaScript to run the algorithms. We need JavaScript to run the authorization process (JSON in open API of different open APIs), and the script to aggregate all data in collected. HTML is the language that is used for visualization of the website. For example, the text font, size, and also the spacing can be modified using HTML.

As shown in Fig. 7 below, users are presented with key statistics from the applications they have integrated as soon as they have opened the dashboard WebApp. This is designed to minimize the number of operations needed for users to access information. As they scroll down, more information for other integrated applications is shown.

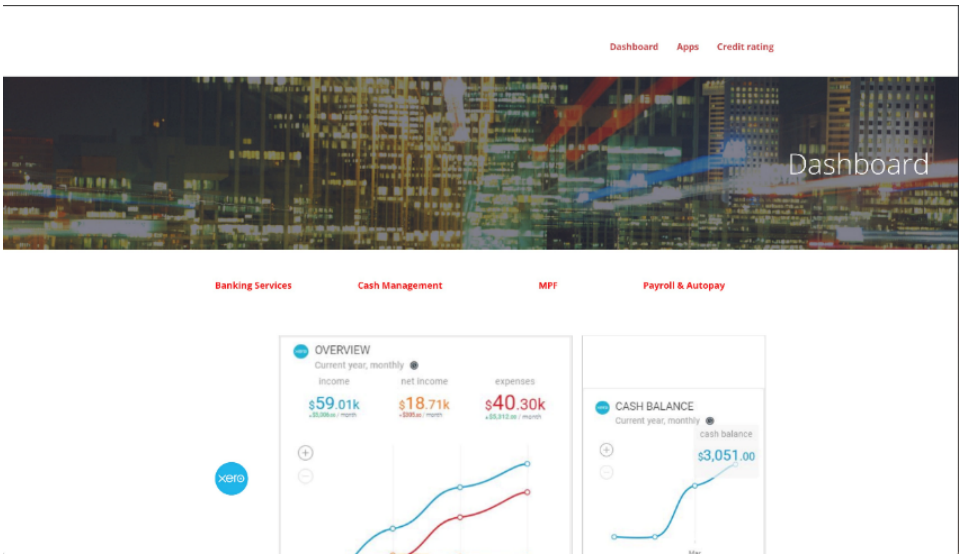


Fig. 7 Prototype design of the dashboard interface

Third-party applications:

API ports from different third-party applications are used to transfer information to the dashboard with the third-party app standardizing their format of the information. In order to achieve this, individual negotiations with third-party firms are needed. The scopes of information provided by different application vary greatly and require a customized API port. Moreover, the webpage should consider different ways of authorization process among each third party and link them with the APIs, i.e. OAuth [10]. OAuth provides secure delegated process; it shares users' specific information without giving out the credential of users. It will time out at a specific time after the authorization. Therefore, for the webpage that needs to use this kind of APIs, a window will pop up to give notifications to the users when the authorization process is getting time out fail. By the authorization process used, account opening using bank account and integrating third-party app information can be performed securely.

Server:

Data will be stored in the server of the dashboard, and it will be retrieved using MySQL. Once the website obtains the authorization from the user to access user information stored in the third-party application. the API portal between the dashboard and third-party application will be open. By using MySQL, the users can select the type of data from the third-application they wish to display on the dashboard (as not all information from third-party application can be displayed).

Section 3: Credit Rating System

3.1 Introduction

The credit rating system is designed to give more ways for SMEs with poor financial records to prove their creditworthiness. The scoring system is divided into two parts: 1) banks original credit rating system and 2) our innovative smart credit rating system based on information sent back by third-party applications integrating to the dashboard. In this report, the focus will be set on our innovative smart credit rating system.

3.2 High-level overview of smart credit rating system

The smart credit rating system is designed to work with information transferred from apps integrated to the dashboard and create a score that reflects the resilience and business health of the SME otherwise not conveyed by financial records alone.

3.3 Using the smart credit system:

- User integrates the app to dashboard and authorizes information to be used for credit scoring.
- Apps transfer the required information to dashboard via API port.
- For each app, one score will be calculated according to algorithms unique to that app.
- Then all the scores will be normalized and finally aggregated into a total score called “Additional Score” that will be shown to the user.
- In addition to seeing the score, the user may also see individual scores from each app.
- Furthermore, but clicking on the icon of the app, users may gain insight on how the score is calculated and obtain comments on how this score may be improved in the future.

Fig. 8 Prototype design of the credit rating interface

3.4 General remarks and elaborations:

On what kind of apps and information will be used for the smart credit system:

All apps that may be integrated into the dashboard may be used to generate information for the smart credit system. We have divided all the apps into four main categories: 1) bookkeeping, 2) Marketing and analytics, 3) sales and inventory 4) workforce management. The information sent back by each app will vary, and the difference will be significant between apps from different categories. Consequently, each app will have its unique scoring algorithm. How scoring variables are selected from each app and details of scoring algorithms and score normalization will be addressed in the later parts.

Technical aspect:

For bookkeeping apps, the bank will need to provide an API so that SME owners' bank account information can be accessed for the sake of accounting. This falls in line with HKMA's Open Banking API phase three [11]. For the smart credit system to access information needed from third-party apps, banks will need to negotiate with each application to open an API so that the credit system will have access to the information.

3.5 Ideology behind factors/variables selection:

As mentioned before, the main objective of the smart credit system is to prove SMEs creditworthiness using not just financial records. Third-party applications can provide factors/variables that convey the strength of business, market influence, customer base

future growth, and more. “Additional score” is calculated based on these factors and it is important that they are well chosen. The factors/variables selected should reliably reflect the business health and resilience (to default) of SME. Because the scopes of information provided by each app in the dashboard are different, we propose a general guideline on how to check whether a factor should be considered for calculation of the “additional score”:

Factors/Variables Guideline

Under this guideline, we propose three key attributes that should be considered when judging whether a factor should be considered for calculation of the additional score. If the factor can convey information regarding one of the three attributes, then we consider the factor as part of “additional score” calculation.

1) Growth:

An SME that has shown growth in various aspects should be considered when it comes to credit scoring. A growing SME may not have a great financial record at present, but it will likely have one in the future. Specifically, we may consider sales growth, customer base growth, cash flow growth, growth in marketing reach, growth in product reach, etc.

2) Effort:

Strong work ethics and efforts to improve should be considered for credit scoring as well. This attribute draws inspiration from insurance company that rewards users for exercising [12]. Likewise, we believe rewarding hard-working SMEs with a better credit score will motivate them to achieve. Furthermore, drawing parallel to the insurance industry once again, a hard-working SME will be more resilient to bankruptcy and default much like a well-exercised person is less likely to suffer from heart attacks. An SME’s effort is difficult to quantify, however, there still exists some potential indicators. Frequency of promotional posts on social platforms, quickness at responding to customer questions on social platforms, how many business applications the SME has connected and used may give insight on its efforts to improve and grow.

3) Relevance:

Relevance may be how relevant the employees’ skills are to the SME’s field, how relevant the SME’s business is to the current trend in the market, and more. In general, the more relevant the better, and this quality should be considered for credit scoring. This information is again, difficult to quantify, but not impossible. For instance, LinkedIn may show the education background of an SME, and but looking at its employees’ educational level, what they have studied and whether they are the right person for the SME’s business we may check the relevance of SME. In addition, the market trend may also be observed via extensive market data analysis.

3.6 Example variables/factor

LinkedIn and Shopify (both of which are included in the dashboard's integration list) will serve as two examples application to give a more detail elaboration on how variables are picked, as well as how the scoring algorithm works.

1) LinkedIn

Variable	Class 1	Class 2	Class 3	Score (Class 1/2/3)
Followers	0-150	151-400	400+	2 / 4 / 6
Employees from relevant background	0-30%	31-60%	60%+	2 / 4 / 6
Owner's connections	0-250	251-500	500+	2 / 4 / 6
Owner's recommendation	Received recommendation	Not received	N/A	0 / 6

Fig. 9 LinkedIn variables and scoring example

An SME's follower count conveys its company influence and its publicity. The higher the follower count, the more relevant the SME may be in the industry. Percentage of employees from the relevant background also conveys the relevance of the SME. For a business with sub-25 employees, the owner becomes a large factor. Owner's information such as connections, recommendations become valuable insight on the heart and engine of the SME. LinkedIn is a good app to measure the relevance of SMEs.

2) Shopify

Variable	Class 1	Class 2	Score
Constant % increase in sales values	0-10%	10%+	4 / 8
Canceled order as % of total	Under 5%	Over 10%	2 / -2
Returned order as % of total	Under 5%	Over 10%	2 / -2
Variable	Class 1	Class 2	Score
% of loyal customer	10-20%	20%+	4 / 6
% of returning customers	10-20%	20%+	4 / 6
% of at-risk customers	10-20%	20%+	2 / 3

Fig. 10 Shopify variables and scoring example

Data from Shopify, an online commerce platform, can be classified into two categories: 1) sales, 2) customer base. From sales, we specifically look at growth in terms of percentage. We reward SMEs with high growth with a higher credit score. From customer base, we look at the percentage of loyal customers, returning customers and at-risk customers[2]. This information can show the resilience and strength of the business. A business with a strong customer base will be less likely to go out of business or default, hence additional credit score is rewarded.

3.7 Further details on additional credit scoring system

As shown in the above two examples, due to the differences between apps on the dashboard, unique credit scoring algorithms must be designed for each app individually. In addition, due to the difference in nature between different apps (i.e. bookkeeping app vs. marketing and analytics app), comparisons between scores produced by each app is also difficult. Since the ultimate goal is to aggregate the individual scores of each app, we may normalize these individual scores first before adding them together to generate the "additional score". The details of how the scores may be normalized and aggregated are given below.

3.8 Normalization method

Three methods of data normalization and their effects will be explored and compared in this section.

1) Min-Max Normalization

Min-max normalization transforms a value from its original range to a new range [min x_{new}, max x_{new}]. Below is the normalization formula:

$$x_i = \frac{x_i - (x_i)}{(x_i) - (x_i)} (max\, x_{new} - x_{new}) + x_{new} \qquad [13]$$

This method "preserves the relationships among the original data values", which is appropriate for the smart credit rating system use case. Furthermore, it is simple and inexpensive to calculate.

2) Linear scaling to unit range

This method is much similar to the min-max method introduced above, it also outputs the normalized data within the range of [min x_i, max x_i]. This method is also rather inexpensive to calculate and very intuitive. However, according to this study (add

[2] At-risk customers are customers who made more than one purchase but haven't purchased recently.

reference), this normalization outperforms and min-max normalization method when used on a classifier model.

$$\hat{x}_i = \frac{x_i - min(x_i)}{(x_i) - min(x_i)} \text{ [13]}$$

Again, this method maintains the relationships among original values which is desirable.

3) Soft max scaling

This is an example of a non-linear normalization method, and it may be used when the data are not evenly distributed around the mean.

$$\hat{x}_i = \frac{1}{1+e^{-y}} \; where\ y = \frac{x_i - \bar{x}}{r\sigma} \; and\ r\ is\ user\ defined\ parameter \qquad \text{[13]}$$

Since we do not expect our data to be evenly distributed around the mean, this method may be the most suitable normalization method for our case.

In further extension, we will find out the correlation among the indicators with some key factors. For example, profit will be a kind of key factors as it can interpret the ability to return loan directly. We set the lines at 0.5 and -0.5 to show the positive or negative correlation. For the factors, the more positive the correlation, the higher will be the weighting, vice versa. By this means, we will have our initial weighting with some default value and weighting.

For long term score normalization, we will perform machine learning to keep update the model rapidly. As there is more and more information about the social platform, we can include the data in the weighting base but not as an additional score. We will perform a white box machine learning, which is also finding out the correlation among the data to figure out the weighting, but this time, it will be the correlation between the factors and the result of the previous loans. Therefore, the model is sustainable.

Section 4: Business Strategy

4.1 Implementation phases

Phase one: design and initial model creation

- Reach out to the third-parties we intended to work with and negotiate with them to build open APIs.

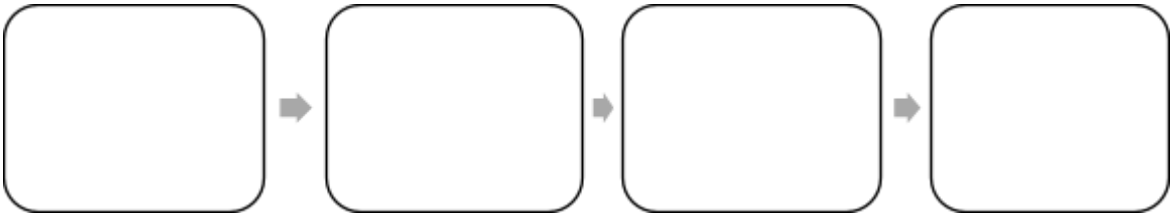
- Design the user interface of our dashboard.
- Create our initial model of credit rating system.

Phase two: API support

- Launch Open API support from third-party Bookkeeping applications firstly and integrate it into the dashboard.
- Follow HKMA's Open API launch phases: aim to HKMA Open API phase 3 (Account information) by early 2020 to integrate users' bank account information.

Phase three: full integration with third-party apps and start credit rating system

- Considering the degree of difficulty of integrating and implementing credit scoring of different categories of apps, we will launch the following third-parties API support in the following order:



- Start credit rating system with bank account information and bookkeeping apps.

Phase four: Credit rating system

- We will implement credit scoring based on different categories of applications in the same order as in phase three.

Phase five: Testing and Monitoring

- Test and monitor the credit scoring system. We can constantly update the scoring algorithms based on user data.
- Gather feedbacks from SME users and improve our dashboard.
- Monitor the usage of third-party apps. We can adjust our strategies relating to third-parties apps.

4.2 Investment and revenue

The revenue of the product is listed as follows:

Sources	Revenue (HKD/year)
Recommendation fee	~200,000
Interest revenue	~4,000,000
Other indirect revenue	~800,000

1) Recommendation fee

A certain percentage of subscription fee is charged as recommendation fee every time SMEs pay to subscribe third-party business applications through the dashboard platform. We assume that 10% of SMEs in Hong Kong are now users of the dashboard and we charge 1% for each subscription. On average, each SME will subscribe to 2.5 third-party applications and annual fee is 250 HKD for one application. Therefore, the revenue from recommendation fee is about 200,000 HKD per year in total.

2) Interest revenue

Considering that the dashboard will attract more SMEs, there will be a rise in the amount of loans that bank gives out. We assume that the amount of loans will increase 100,000,000 HKD per year. The bank will gain about 4,000,000 HKD given that the current loan rate is about 4% and the deposit interest rate is about 0.1%.

3) Other indirect revenue

Other indirect revenue includes the services fee that bank charges when SMEs open accounts in the bank, the revenue generated when SMEs use other bank services and more. It is estimated to be 800,000 HKD per year.

The initial investment in the project is about 6,000,000 HKD. The money will be used in the way as the table shows. It costs 1,500,000 HKD to maintain the platform each year and the maintaining cost may increase at the rate of 5% each year. 3-year ROI of the project is 100%.

Cost classification		Amount (HKD)
Platform development	Storage	~200,000
	Human cost	~5,000,000
Marketing		~500,000

Others	~300,000

4.3 Benefit

For SMEs, the dashboard will make the loan process much easier, reducing the paperwork and hence it is faster. Transparency of the credit rating system also lets SMEs have a deeper learning about their business and know what they need to improve. With an aggregating different account of the SMEs on the dashboard, it not only makes the process of using bank service easier but also provides SMEs a convenient tool to manage their business. Owners can read all the data in their accounts that linked to the dashboard and explore more third-party application on the dashboard.

For banks, reducing the paperwork and let the computer to perform the rating work can clearly lower the cost. More importantly, the credit rating system can assist banks in risk management and lower the bad debt rate. The dashboard can also provide business services like advisory service with the help of third-party applications. This means the bank can provide different business services that exist in third-party applications with a very low cost. The services and convenience provided by the dashboard will build up the bank's reputation and the client base will increase. The data collected from the dashboard can also be used to analyze the business behavior of different kinds of SMEs, so that the bank can provide new products that targeting SMEs, attracting them to try more business services in the bank.

Section 5: Innovation and Feasibility

5.1 Innovation

Using machine learning, the credit rating model can be improved and updated time by time. When users start to use the credit rating system, the database (which consists of the credit rating score, different factors used, and eventual outcome of the loan) will have sufficient information to be used as training dataset. Below is a table that illustrates the training dataset.

Features	Outcome
Factors used to compute the score	Default (Yes/No)

The expected outcome of machine learning is to discover the relationship between factors and outcome of the loan (whether the SME has defaulted) and create a more accurate credit rating system.

Machine learning can be classified into two different types, white box and black box. White box machine learning is that the structure and the development of the model can be known, which implies the relationship and influence of the variables can be known too. Black box machine learning is that nothing is known inside and we can't interpret the model. In this case, white box machine learning is chosen and Random Forest will be the method. Actually, Random Forest is a kind of black box machine learning method. However, we can turn it into white box if we break down the Random Forest into different Decision Trees and study the decision path of the trees. Hence, we can compute the final outcome by calculating all the features contribute by the trees.

$$RF(x) = \frac{1}{j}\sum_{j=1}^{j} bias_j(x) + (\frac{1}{j}\sum_{j=1}^{j} contr_j(1,x) + \ldots + \frac{1}{j}\sum_{j=1}^{j} contr_j(n,x)) \text{ [14]}$$

Therefore, we can study the influence of different indicators and renew our model. Hence, this can be easily explained to the users that the rating system is fair to them.

5.2 Feasibility

The SME market is big enough for the dashboard and it is believed that the dashboard can satisfy the business need of SMEs. From the survey of HKMA done on SME credit conditions for the fourth quarter of 2018 [4], 22% of respondents perceived more difficult credit approval stance relative to 6 months ago. While the proposed credit rating system will provide a clearer environment to SMEs about the credit rating, it is believed that SMEs can get their loan easier under the system. As by December 2018, there were about 340 000 SMEs in Hong Kong. The dashboard will attract more SMEs to use and hence the client base of the bank can be increased.

For the technical part, all the technology needed is existing technology (i.e. Open APIs, machine learning). One thing that is not fully fulfilled is that the data needed may not be obtained from existing third-party APIs. Hence, negotiation with third parties is needed. The dashboard needs to partner with some third parties in order to ensure the data obtained is reliable.

Section 6: Conclusion

In this project, two major problems are defined: the lack of support problem faced by SME owners and the asymmetric information problem between the banks and SMEs during the bank loan applying process. To solve the first problem, a smart business dashboard is designed. Within the dashboard SME owners can track their businesses, access to third-party applications, and view their credit rating. About credit rating, a system based on the data obtained from bank account and third-party applications is designed to provide more accurate credit assessment. Furthermore, implementation phases of this project are discussed. Additional possibility of using machine learning

to improve the credit rating system is also addressed. The complete Smart Credit Dashboard will be a powerful solution to the current SME problems, and it will help SMEs with their business management, speed up the bank loan applying process and give SMEs more ways to prove their creditworthiness.

Reference List

[1] EY, "EY Consulting," December 2018. [Online]. Available: https://www.ey.com/Publication/vwLUAssets/EY-The-future-of-SME-banking/$FILE/EY-The-future-of-SME-banking.pdf. [Accessed February 2019].

[2] Support and Consultation Centre for SMEs, "Small and medium enterprises (SMEs)," [Online]. Available: https://www.success.tid.gov.hk/english/aboutus/sme/service_detail_6863.html. [Accessed 24 April 2019].

[3] CPA Australia Legal Business Unit, "CPA Australia Asia-Paciic Small Business Survey 2018," 27 March 2019. [Online]. Available: https://www.cpaaustralia.com.au/~/media/corporate/allfiles/document/professional-resources/business-management/small-business-survey/small-business-survey-2018.pdf?la=en. [Accessed 24 April 2019].

[4] Hong Kong Monetary Authority and Hong Kong Productivity Council, "Survey on Small and Medium-Sized Enterprises (SMEs)' Credit Conditions," 19 February 2019. [Online]. Available: https://www.hkpc.org/en/industry-support-services/latest-information/7290-hkma-survey. [Accessed 24 April 2019].

[5] Hong Kong Monetary Authority, "Survey on Small and Medium-Sized Enterprises (SMEs)' Credit Conditions for Fourth Quarter 2018," 19 February 2019. [Online]. Available: https://www.hkma.gov.hk/eng/key-information/press-releases/2019/20190219-3.shtml. [Accessed 24 April 2019].

[6] "About Xero," [Online]. Available: https://www.xero.com/hk/about/. [Accessed 24 April 2019].

[7] "Xero and HSBC - tools for successful Hong Kong businesses," [Online]. Available: https://www.xero.com/hk/partnerships/hsbc/. [Accessed 24 April 2019].

[8] "Neat Business Features," [Online]. Available: https://www.neat.hk/business/features. [Accessed 24 April 2019].

[9] "9SPOKES," [Online]. Available: https://www.9spokes.com/. [Accessed 24 April 2019].

[10] "What is OAuth? Definition and How it Works," [Online]. Available: https://www.varonis.com/blog/what-is-oauth/. [Accessed 25 March 2019].

[11] Hong Kong Monetary Authority, "Open API Framework for the Banking Sector and the Launch of Open API on HKMA's Website," 18 July 2018. [Online]. Available: https://www.hkma.gov.hk/eng/key-information/press-releases/2018/20180718-5.shtml#1. [Accessed 25 March 2019].

[12] C. Farr, "CNBC," CNBC, 29 January 2019. [Online]. Available: https://www.cnbc.com/2019/01/28/apple-aetna-team-up-on-attain-health-tracking-app.html. [Accessed March 2019].

[13] B. K. Singh, K. Verma and A. S. Thoke, "Investigations on Impact of Feature Normalization Techniques on Classifier's Performance in Breast Tumor Classification," *International Journal of Computer Applications,* vol. 116, no. 19, 2015.

[14] A. Saabas, "Interpreting machine learning models," [Online]. Available: https://www.slideshare.net/andosa/interpreting-machine-learning-models. [Accessed 20 4 2019].